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LAST YEAR on a visit to Pretoria, South Africa, a small group of us were invited by Dr. J. G. Stander, Director of the government's National Institute for Water Research, to try a Lily cup of water. The clincher: it had been drawn off the end of a complex system of filters and plumbing (shown below) which it had entered as raw sewage from the city's waste pipes. The water was unpleasant to contemplate, but certainly not unpleasant to taste. In fact, when com-

THIS MONTH



pared with a sip of regular spring water that Dr. Stander had handy, the sewer by-product actually had less taste. It was a good example of what can be done to help solve not only a major problem of world pollution, but also a global problem of vanishing water tables. With pollution rampant in a suddenly pollution-conscious world, what's happening in Pretoria is just one of many projects here and abroad aimed at re-using many of the waste by-products of human existence that we have been accustomed to "dump" almost anywhere. *Science Digest's* assistant editor, Barbara Ford, has dug up dozens of such projects now underway, and tells about them on page 22.

—RFD

SCIENCE

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Editorial and general offices:

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Subscription offices:

250 West 55th Street, New York, N.Y. 10019

Advertising offices:

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This handsome Irish setter's ancestors were among the world's most useful and intelligent field dogs. Unfortunately, many of this breed are now worthless as field dogs because of breeders' emphasis on show dog characteristics. Dozens of other dog breeds have been similarly ruined because of breeding practices. The story is on page 41.

Cover photograph by Paula Wright



DECEMBER • 1970

Vol. 68, No. 6

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NEWS

IN BRIEF

Bulletins at press time

MANNED SPACE FLIGHT ITINERARY ANNOUNCED by NASA for its multi-billion-dollar space station, shuttle and exploration programs includes: 1. Apollo 14 manned launch on January 31 to the Fra Mauro region, where astronauts will drive a four-wheeled lunar rover across moonscape. 2. Apollo 15 manned landing on July 25 near a lunar rille and some of the moon's highest mountains. 3. A 12-man orbiting space station with four levels of specialized compartments, programmed to circle the earth for 10 years starting in the mid 70s. 4. Search for a new launching site other than Cape Kennedy, from which regular space shuttles will blast off starting in 1977 or '78.

CIGARETTE SMOKERS WHO SWITCHED TO FILTERS for 10 years or more show a decreased incidence of lung cancer, according to a survey reported by the Journal of the American Medical Association. The study involved 350 lung cancer patients and 700 control persons who had no history of tobacco-related diseases. The study also revealed that risk declines after four years of complete cessation of smoking and approaches the level of non-smokers after 13 years of smoking abstinence.

AMONG THE SAVORY SALAD HERBS thriving in "The Garden of Fragrance" at Rochester (N.Y.) Museum and Science Center, horrified museum officials recently discovered three lusty marijuana plants--also thriving. The museum's embarrassed director suggested that the seeds were probably carried in by the wind and recommended to the gardener that he tend more closely to his weeding.

SLEEP IS A LONG WAY FROM A QUIET AND PEACEFUL STATE, according to the report of two physicians at a California sleep research facility, Drs. Anthony and Joyce Kales. Patients with coronary problems often experience severe chest pain associated with dreaming, and ulcer patients frequently awake with severe abdominal distress during dream periods in sleep phase, they note. The survey also revealed that children "outgrow" sleepwalking, night terrors and bedwetting; that the latter appears to be caused by inadequate bladder capacity, and not psychiatric problems.

NOW FOR \$20, YOU CAN DIET BY COMPUTER through a new computer company in Philadelphia known as a Computer Diet Control. The company reports that the electronic brain will match your food preferences against such factors as your height, weight and health inputs. Out comes a 30-day weight-reducing menu, geared to keep you healthy while restricting your own inputs to proper proportions of the goodies you like so that calories don't multiply. As of press time, more than 2,000 reducers had signed up.

MYSTERIOUS INGREDIENT OF POLYWATER -- SWEAT, according to Dr. Robert Davis of Purdue University. The controversial new form of water that created an international scientific donnybrook two years ago (some scientists insisted it was a dramatic new form of water; others said it was merely everyday water with pollution) has been undergoing expensive laboratory tests everywhere—including Russia where it was "discovered." Dr. Davis found studies in a Russian journal providing evidence that samples of "polywater" claimed to be pure, were loaded with human perspiration. The hundreds of thousands of dollars spent investigating the substance has been wasted, says Dr. Davis, "...unless it can be defined as a topic of water pollution and waste disposal."

OFF WITH THEIR LEGS! is the recommendation of Dorothy Skinner and Dale Graham, Oak Ridge, Tennessee biologists, as a method of halting the depletion of Alaska king crabs. Noting that removal of pincers from several crab species often hastens moult and quickens regeneration of the parts, they suggest that instead of taking the whole crab, Alaskan crabbers detach a few legs from each crab and throw the rest back so it can grow new appendages. The legs are all that is eaten of the king crab. Taken at the proper season, a crab with plucked legs will quickly grow new ones.

PREGNANT RATS BREATHING MARIJUANA produce offspring with genetic defects, according to Dr. Vincent Lynch of St. John's University in Queens, N.Y. The rats, exposed to smoke equivalent to one cigarette a day for 10 days, produced serious defects in 20 percent of the offspring. The findings are believed to establish an important link between marijuana smoking and the developing human fetus.

Letters to the Editor

Computer art is 'fake'

I read your interesting article, "Creative Computers" in the August 1970 issue (p. 9). Things that look or sound like art might be spewed out of computers, but they can never be art. Art is communication between human beings. Computer art lacks the one essential ingredient of art. It lacks life. Art is the product of a human being's reaction to life. A computer has no life or reactions.

EUGENE WALKER
Detroit, Michigan

'Priceless jewels'

The subjects your magazine covers are extremely interesting. The average student is able to comprehend most everything. Dr. Asimov's columns are like priceless jewels.

W. VETERNIK
Kenosha, Wisconsin

Chimp or homosapien?

The chimpanzee Washoe on the front cover of the May 1970 issue has hands of a homosapien—not of a chimp!

DR. JOSEPH E. PEHLMAN
Durango, Mexico

We have consulted with an anthropologist who has done comparative studies of primate hands to see if our

artist has misrepresented the chimp hand. His reply follows.—Ed.

[Regarding] the chimpanzee on the cover . . . the right one [hand] is acceptable except that the terminal phalanx of the thumb is a bit square as opposed to conical. The left thumb is much too broad and perhaps also long relative to the other digits.

RUSSELL H. TUTTLE
Associate Professor
of Anthropology
The University of Chicago

Concerning crud

I certainly enjoyed Dr. Marston Bates' article, "CRUD," August 1970, p. 34. Incidentally, "crud" is *not* a coined word, unless the GIs accidentally hit upon the expression. Crud is the Danish word for black gunpowder, which is dirty, all right—but not obscene. See *One Hundred Great Guns*, Merrill Lindsay, Walker and Co., 1967, p. 17.

WILLIAM BRACE FIELDS
Mansfield, Ohio

Please save the Pandas

I am interested in ecology, so your article, "Where Have All the Pandas Gone," [September 1970, p. 76] interested me very much. It is a shame that we can't keep the panda from extinction, for it looks like they're headed that way.

NICOLE SHAVER
Portland, Oregon

Thanks for your magazine

I wish to take this opportunity to express how much I enjoy reading *Science Digest*. I think it is one of the

most fascinating books on the market. It is a very informative little book—one which has greatly increased my knowledge of the broad field of science. This magazine has afforded me many hours of interesting reading.

MARSHALL COLLISTER

Pun quiz not 'punny' enough

I enjoyed your article on puns ["Test Your Creativity," September 1970, p. 23], but felt that the test at the end was not a true test of creativity. Most of the words in the list were merely compound words, and all that you did was to split the word into its two bases. A genuine pun should come into context. For example, after taking your quiz on shells ("How Good Are You As a Malacologist?", p. 82), I exclaimed, "Abalone!"

BOB BLACKMAN
East Lansing, Michigan

Some of the words used in the quiz for "pun" formation are actually very old jokes that many people would know regardless of their Creativity Quotient. The article misuses the word "pun." Your examples and test answers show clearly that what you are seeking are not true puns, but what is called "daffynitions." The word "daffynitions" is an example of a pun. It refers to a real word being given a humorous and obviously false definition.

SAMUEL A. SHAFTE
New York, New York

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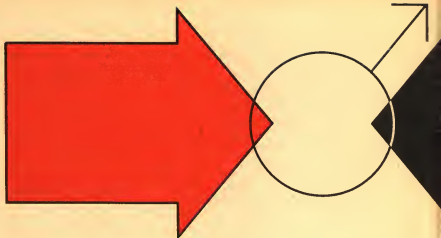
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I certify that the statements made by me above are correct and complete.

RICHARD F. DENPEWOLFF, Editor



Scientists are discovering that biological causes of human aggression appear to be as important as psychological or sociological ones.

by Frederick C. Klein

“WHEN I WAS PLAYING in a sandbox I hit myself on the head with a claw hammer. Accidentally. I knocked myself out. Then, a few years later—I must have been about 10—I was playing with some kids. They chased me and I climbed into a tree. I hid there for a while, maybe 10 feet from the ground, and lost my hold. I fell on my head. My sister found me. She thought I was dead. I was out for an hour and a half. About five years after that, I did it again. I was running down a street and ran my head into a steel awning rod. I was knocked out again. See that patch of light-colored hairs

on my head? That's where it hit me.”

The speaker was Richard Speck, as quoted in a book by Dr. Marvin Ziporyn, the psychiatrist who attended him in Cook County Jail while he awaited trial for killing eight student nurses in a Chicago apartment on July 14, 1966. Dr. Ziporyn believes that the head injuries described by Speck, along with several other serious injuries and ailments the 25-year-old itinerant worker had suffered, led him to commit the murders for which he was later convicted and sentenced to death. (The conviction is now being appealed to the Supreme Court.)

“Speck was a killer because his brain was damaged; given the circumstances of his life, his lethal outburst was inevitable,” says Dr. Ziporyn. “Behavior is as much a physiological activity as breathing and eating. We don't know as much about it, but that doesn't change the basic fact.”

Such views are by no means universally held, but they have been receiving an unprecedented amount of scientific attention of late. Researchers in increasing numbers are delving into the biological causes of violence, fo-

THE CHEMISTRY OF VIOLENCE

cusing on the role of genetics, bodily chemistry and brain illness and injury in producing aggressive behavior.

Until recent years research into human violence had been almost solely the province of psychologists and sociologists, whose studies stressed the influence of upbringing and environment. Those close to the current biology-based efforts readily admit that theirs is a relatively new field and that most of their findings to date have been preliminary.

Yet "even at the present, exploratory stage the work has established that biological causes of violence are as important as the psychological or sociological ones—that no single discipline has a monopoly on the subject," says Dr. Saleem Shah, chief of the Center for the Study of Crime and Delinquency at the National Institute of Mental Health, the Federal agency that is sponsoring many studies in the area.

Dr. Frank Ervin, head of the Stanley Cobb Laboratories for Psychiatric Research at Massachusetts General Hospital in Boston, goes further. "When I look at people with the most

deprived sorts of backgrounds, I am always impressed at how few of them become criminally violent," he says. "It would be silly to deny that environment is important, but when I see people who have a long history of violence I'm always impressed at how many of them also have medical histories that indicate organic brain damage."

Probably the most basic—and at the same time most problematic—area of violence research is into the role of genetic abnormalities in aggressive behavior. The cells of most individuals usually contain 23 matched pairs of chromosomes that determine a person's mental and physical makeup, but investigations to date have focused mainly on just one of these sets—the sex chromosomes.

Research into sex chromosome irregularities first gained wide notice several years ago, when it was found that the perpetrators of two especially brutal European sex murders had an extra Y chromosome in their blood

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cells. (A "normal" male has one X and one Y sex chromosome; a "normal" female has two Xs.) This finding gave rise to the "XYY Aggressive Criminality Syndrome" theory, which held that men with an extra Y tended to be super-aggressive and prone toward sex-linked crime.

Further studies proved this notion to be an oversimplification—the big majority of sex crimes have been found to have been committed by men with normal sex chromosomes and most known XYY men don't commit any sort of crimes. Nonetheless, several recent surveys have shown that a small but significant number of sexual offenders have *some* extra sex chromosome material, either an extra X or an extra Y.

Odd sex chromosomes

One of these studies was conducted by Dr. Lawrence Razavi, a Stanford University medical school geneticist. He ran chromosome tests on 83 adult male prisoners and found that 12 of them—about 14 percent—had abnormal sex chromosomes in at least 20 percent of their blood cells. This is between 25 and 30 times the proportion of such irregularities in general adult male populations tested.

Moreover, Dr. Razavi and others also have found that most men with odd sex chromosomes have fingerprints that differ markedly from those of other men; they have fewer ridges and fewer loops and whorls. This finding is important because it promises to make more efficient the search for individuals with such abnormalities. Large-scale studies in the area now are difficult because chromosome analysis is expensive and time consuming.

Dr. Razavi cautions that it's far too early to make any broad generalizations from findings to date. But he adds: "What we seem to have is a small but important group of people whose biological oddness makes them especially vulnerable to social pressures that most people can handle easily. Sex crime seems to be one result of this oddness. There may be others."

The oldest and most active area of research into the biology of violence concerns the bodily chemicals that appear to stimulate or suppress aggressive behavior. A main focus of this type of study has been the role of blood constituents, particularly the glandular secretions called hormones.

It has long been known that certain sex hormones are associated with aggression. Male cattle whose supply of androgens, the "male" hormones produced by the sex glands, has been reduced by castration are far more docile than bulls. Acts of violence by human females have been linked to the irritability that accompanies premenstrual hormone changes. One study showed that 62 percent of the violent crimes committed by 249 women's prison inmates took place in the week preceding their menstrual period.

Recent research has discovered other apparent links between hormones and violence. For example, it's generally recognized that frustration and stress, especially if prolonged, often culminate in violent acts, and several studies have indicated that such mental states may impair the functioning of the adrenal and thyroid glands.

Some hormones have been found to modify the actions of others. Severe menstrual irritability has been suc-

"Particular hormone balances make the system sensitive to situations that might evoke attack."

cessfully treated with progesterone, another hormone. Estrogens, the "female" hormones, have inhibited aggressive behavior in men and other male animals.

"What we've found is that particular hormone balances make the human system 'touchy' or sensitive to the type of situation that might evoke attack," says Kenneth Moyer, professor of psychology at Carnegie-Mellon University in Pittsburgh and a leading hormone researcher. "What we don't know yet is the way these balances act on the brain and thus modify behavior."

Efforts to answer the latter question have been advanced in the past few years by the development of techniques that permit scientists to study the effects of various chemicals on the brain. Most such studies have concentrated on the action of the neurons, or nerve cells, that transmit "messages" for the control of the body and behavior. These messages move from neuron to neuron through chemicals that function as transmitters, in much the same manner as certain fluids conduct electricity in batteries.

Late last year, Dr. Donald Reis, professor of neurology at Cornell University medical college, reported that he had identified one neurotransmitter, norepinephrine, as the substance that triggers violent reactions in cats. Other research has identified a number of externally introduced chemicals that either block or elicit the specific act of killing in experimental animals. A team of scientists at Princeton University re-

cently announced that rats that received tiny doses of methyl atropine through tubes implanted in their brains didn't kill mice placed in their cages; before the drug was administered, they had dispatched such mice quickly. Other chemicals applied by the Princeton group turned ordinarily unaggressive rats into killers.

Some scientists believe that small amounts of alcohol can set off extreme violent reactions in some human beings. Dr. George Thompson, a Los Angeles psychiatrist and neurologist who has done extensive work in this area, calls this effect Pathological Alcoholic Intoxication (PAI). He says that electroencephalograph (EEG) recordings of the brain waves of some persons who have had as few as two drinks look much the same as those of individuals suffering from psychomotor epilepsy, a disease that sometimes results in sudden, violent behavior that the person can't remember later.

Violence and drinking

Most people who have similar violent reactions after drinking have sustained head injuries that suggest brain damage, Dr. Thompson says. Indeed, he believes that PAI and psychomotor epilepsy are "essentially the same disease" and are "merely produced by different triggers."

Another key area of violence research involves pinpointing the part of the brain that controls aggression. Animal experiments indicate this is the so-called limbic system, consisting of a number of small brain structures

that also govern behavior linked to emotion and instinct, such as sex and eating.

Limbic structures are situated in the central base of the brain, beneath a far larger mass of cortical material. They have been shown to be especially vulnerable to injury. One survey of auto accident victims who underwent brain surgery or autopsy showed that brain damage occurred most often in the limbic region.

Physicians say that a wide range of other injuries as well as illnesses can damage limbic structures. Among the dangerous illnesses are strokes, brain tumors and any ailment that involves a very high fever over a long period of time. Charles Whitman, the young man who shot and killed 13 people from a University of Texas clock tower in 1966, was later found to be suffering from a brain tumor.

Brain damage effects

The most dangerous period for brain damage is between birth and three years of age, when the individual is most susceptible to the results of high fevers and illnesses that reduce oxygen supply. At three months, Richard Speck had an attack of pneumonia so serious that he required an oxygen tent.

Measles in an expectant mother can cause brain damage to her unborn child; so can a lack of protein in her diet. Observers point out that all types of prenatal injuries appear to be most common in the urban and rural poverty centers where violence is most frequent.

Identification of the effects of specific types of brain disorder on behavior can't be made with certainty now because the main instrument for

detecting damage—the EEG—is a far from perfect tool, physicians say. Moreover, one recent study suggested that violence-linked brain disorder may stem from the scar that results from a brain injury rather than from the injury itself and that the scar may take more than a year to form. This lag would help explain why head injuries often aren't readily connected with individual acts of violence.

The act of violence itself may not be easily recognized. "Instead of fighting, a lot of violence-prone people take out their aggressions behind the wheel of their cars," says Dr. Ervin of Massachusetts General Hospital, who over the past 18 months has examined some 200 people with histories of violence. "One guy I see gets involved in so many traffic hassles that he can't get to work on time. If he thinks another driver cut him off or something, he'll go miles out of his way to chase him down and tell him off."

Some types of medical treatment have been devised for individuals who are violence prone, but progress has been limited. The use of several antidepressant and anticonvulsant drugs has met with some success, but they don't affect all patients the same and little is known about their long-term side effects. Surgeons in several countries, including the U.S., have calmed extremely violent people by brain surgery, but this is a last resort.

"Right now, if a fellow gets into a lot of fights, people call a cop, a lawyer, a minister, a social worker—anyone but a doctor," says Dr. Ervin. "If we're going to make any real headway, the first thing we'll have to do is get people to recognize recurring individual violence as a medical problem." ■

Did you know that...?

DID YOU KNOW THAT the romantic nonsense about mistletoe may be the biggest snow job ever perpetrated? The plant is actually a parasite that grows on almost every variety of tree in the U.S. There is even one type of mistletoe that grows on other mistletoe. Often a heavily infested tree will sicken or die. How romantic!

Birds spread mistletoe. They eat its berries, then wipe their bills on tree branches to get rid of the sticky seeds. The seeds remain on the branches until spring, when they sprout.

Apparently mistletoe owes its romantic appeal to a Norse legend, which says that the god Balder was killed by an arrow made of mistletoe. In one version, however, he is revived and the mistletoe given to the goddess of love. She decreed that henceforth anyone passing beneath the mistletoe should receive a kiss as a love token.

—Maxine Glassman

Hot water freezes fast

Three hundred and fifty years ago Francis Bacon, English philosopher and scientist, wrote in his book *Novum Organum*: "Water slightly warm is more easily frozen than quite cold."

Here was something to challenge scientific thought. Bacon had proposed something which seemingly contradicted not only scientific laws but also plain common sense. But scientists did nothing to prove or disprove Bacon's statement. They also refused to even consider that hot water freezes faster than cold water. It obviously was impossible.

But it does. And Dr. George S.

Kell, a 39-year-old chemist with the National Research Council of Canada, for the first time has proved scientifically that an open bucket of hot water can freeze faster than one of cold water. His research involved a computer calculation based on simple thermodynamic principles and experiments made outdoors during an Ottawa winter.

Dr. Kell, of the High Pressure Section of NRC's Division of Chemistry, found that if buckets of water are covered, cooling takes place as described by Sir Isaac Newton's law of cooling—the cooler of the two buckets will remain the cooler until the water in it freezes.

However, if the buckets are not covered, evaporation plays a major role in the freezing of the one containing the hot water. So much of the hot water evaporates that this more than compensates for the greater temperature range it must cover before freezing. In short, there is less water to freeze in the hot bucket and it cools and freezes faster.

Dr. Kell's experiments showed that as water cools from 100°C to 0°C., some 16 percent of it evaporates. Another 10 percent vaporizes as the liquid turns to ice. In other words, if 100 pounds of boiling water is poured in a large wooden tray, more than 25 pounds of it will evaporate before it freezes.

He also found that when the temperature of the cold environment is 20°F., very hot water can freeze about 10 percent faster than an equal volume of water starting at room temperature. Water takes the longest time to freeze when it starts at 73°F. ■



Pictorial Parade

Wake up with a breath of pure oxygen

British motorists who get drowsy can perk themselves up by breathing oxygen from a pocket-sized dispenser like the one this woman is using. It's also recommended for use for motorists or business executives who feel tense or fatigued. British motor organizations frown upon the device however, declaring that artificial stimulants of any sort cannot substitute for rest. Similar devices are available in the U.S. but come with identical warnings from experts.

Seeing inside the brain with radioactivity

By injecting harmless radioactive material into the arteries leading to the head, scientists at UCLA can look at the living human brain more clearly than ever before. Special video cameras sensitive to the radioactive material project the journey of the material through the brain passageways and can indicate if there is any brain disorder. The way the radioactive materials linger in certain regions or detour around obstructions give important medical clues.



BIPS

People behave differently when police are around

You can buy a sticker for your car in England that reads, "I am not afraid of the police because I have done nothing wrong." "Police" is ten times bigger than other words, making your car look like a squad car. Police admit infractions are down.

BIPS





Tooth decay may be totally eliminated

A new paint-on material called Epoxylite Fissure Sealant promises to virtually stop all tooth decay on occlusal surfaces. The sealant is applied to the teeth by a dentist or hygienist in a simple two-step process which seals off the microscopic cracks and fissures where most tooth decay begins. The teeth are first thoroughly cleaned and then the plastic sealant is applied and dried with a gentle stream of air. Epoxylite Corp., South El Monte, Calif.

How to keep your Christmas tree green and fresh

To one gallon of water add two cups of light corn syrup, four teaspoons of chlorinated bleach and four tablespoons of Green Garde Micronized Iron. This homemade recipe is supposed to help keep your tree fresh only if it still has 80 percent of its original moisture. If it has been cut too far in advance, chances are no amount of special care can keep it fresh or prevent its needles from falling prematurely. Encap Products, Mt. Prospect, Illinois.



BIP'S

Psychedelic lights borrowed to help deaf children speak

Psychedelic lights flashing in response to the sound of a deaf child's voice are teaching speech where before it had seemed hopeless. At Larchmoor School for the Deaf in Buckinghamshire, England, five boys and a girl (all deaf) are now learning to use their voices for the first time by making sounds into a microphone which automatically causes colored lights to flash on a machine in front of them. The children range in age from nine to 13.



Fog chasers

ONE OF AVIATION'S most costly problems is fog over airports. At least \$75 million a year is a conservative estimate of what it costs to deal with the monumental air traffic jams resulting from fog. But the Air Transportation Association of America hopes that a partial solution may soon be available.

World Weather, Inc., of Houston, Texas, has developed a machine called "Fog Sweep," a 100-foot long tube which sprays fog-dispersing chemicals into the air high over airports so that planes can land.

Gene Kooser and Tom Bucchino, the owners of World Weather, believe that fog can be dispersed effectively using their device and have set out—with a \$100,000 contract from 34 U.S. and Canadian airline firms—to prove their theory.

What is this mysterious chemical that chases away the fog? World Weather won't tell; they're afraid of competitors. But they do say that the chemicals are non-toxic.

How do the chemicals work? Kooser reports that they cause the minute moisture droplets of fog to

combine into larger droplets, often producing rain.

Kooser and Bucchino have also taken their spraying equipment aloft in an airplane with, reportedly, great success. The plane is rigged with piping and nine nozzles for the liquid chemical, and under the fuselage is a larger single nozzle which sprays the chemical in powder form. Each run of the plane can cut a 300-foot path through the dense fog. Windy days, however, tend to erase most of Kooser and Bucchino's efforts. ■

Giant arm of the 100-foot "Fog Sweep" (opposite) can reach high enough over a runway to clear a path for an airplane to land safely.

Photo Trends



Airplane sprays fog-dispersing chemical into the fog above and is successful in chasing away fog (below) a few minutes later. Windy days are hindrance, however.





The fact and fiction about **CHOLESTEROL**

Does cholesterol really deserve the reputation it has received in recent years? One medical doctor brings us up-to-date on what is known about this alleged man-killer.

by Joseph D. Wassersug, M.D.

A STUBBORN, 94-YEAR-OLD LADY patient of mine adamantly has refused all dietary advice (and still does, I might add). She enjoys her bacon and eggs (both rich in cholesterol) every morning and, as an added gesture of defiance, dips her bread into the bacon fat and eats that too. She happily shared the ice cream and goodies with her guests at her recent birthday party. But at 94,

even the most conservative dietician must admit that, obviously, cholesterol didn't shorten her active life. Some people might even claim, with some justification, that it may have contributed to her vigor and longevity!

It's almost half a century since doctors first suspected that cholesterol was a secret killer, doing its dirty business by clogging the arteries going to the brain, heart and other organs. Today, in spite of all

the public hysteria about cholesterol in diet, skeptical scientists are still not sure. What are the facts? Is cholesterol really a man-eater?

Cholesterol is generally regarded as one of a number of complex greasy chemicals related to the fats, although scientifically it is really classified with the heavy organic alcohols. It is present in many foods, particularly animal fats. Bacon, lard, butter, beef-fat, cream and egg yolk all contain relatively large amounts of cholesterol. Fish, fruits, vegetables contain very little of the substance. Cholesterol is also present in varying amounts in your blood. That's what makes it a problem, and sometimes a potential killer.

But cholesterol is not the only fatty substance in the blood. There are also triglycerides such as beta-lipoproteins, abnormal beta-lipoproteins, pre-beta-lipoproteins and, perhaps, still others as yet unidentified. Cholesterol is the easiest of the bunch to detect and measure. Testing for cholesterol is like looking for your lost watch under a lamppost because the light is better there. It may not be the *right* place to look but it is the brightest.

Cholesterol and other fatty substances in the blood are lumped together as "serum lipids," and an abnormal increase of these substances is called "primary hyperlipidemia." The term "primary" is used to indicate an essential difference from the average since all of us will show a transient "secondary" rise in blood fats shortly after eating a diet that is rich in fat. The person with "primary hyperlipidemia" has too much fat in his blood even when his blood is examined early in the morning after an overnight fast.

Now the problem of testing just for

cholesterol becomes even more complicated because many doctors feel that there are five classes of blood lipids, according to schedules based on the research of Dr. Donald S. Fredrickson of the National Institute of Health. Ideally each of these five categories should be tested and each treated with the diet that is most appropriate. In one sense, then, there is no *one* low cholesterol diet but *five* of them. But even this concept needs to be further amended as will be pointed out later.

Not a poison

Most important, *cholesterol is not a poison or a foreign substance* (like arsenic or lead) in the blood. Cholesterol is an important constituent of the body and its basic structure is reflected in some of the most complex hormones and vitamins that are essential for life and health. To preserve its vital cholesterol, the body has devised a most intricate protective system, so complicated that it is now only barely beginning to be understood.

According to a recent report by Drs. John M. Dietschy and Jean D. Wilson of the University of Texas, "The synthesis, absorption and destruction of cholesterol in the mammal is controlled by complex, interlocking feedback mechanism (or mechanisms), of which bile acids and cholesterol themselves are the principal mediators."

At least two sources of cholesterol are available to the body; first, that which it gets as cholesterol from the diet and, second, that which it creates or synthesizes itself from simpler dietary constituents. *In other words, the body can make its own cholest-*

"It is almost impossible to regulate the amount of cholesterol in the blood . . . by diet."

terol, as much as it seems to "need," even if the diet contains absolutely no cholesterol.

Although the data in humans is not as fully detailed as in other mammals it is likely that there are no great differences between comparable species. For example, in the squirrel monkey, 97 percent of all its cholesterol manufacture or synthesis is carried out by only two tissues, the liver and the intestinal tract. The skin contributes another one percent to the total synthesis. Here the body uses simple *acetates* building them up stepwise through enzyme action to the giant cholesterol molecule.

Much of the mystery of cholesterol synthesis has been elucidated in the past decade or two through research using acetates "labeled" with Carbon-14. Matter of fact, most experts today believe that *every mammalian tissue is capable of at least some degree of cholesterol synthesis* using simple acetates as starters.

Three factors control the amount of cholesterol that the body synthesizes: (1) amount of cholesterol in the diet, (2) total calories in the diet and (3) a normally functioning circulation of bile acids through the liver and intestine. When the diet is rich in cholesterol, the body synthesizes less cholesterol. When the diet contains more calories, more cholesterol is synthesized. If bile and bile acids are drained out of the body by a tube in the hepatic duct and the bile acids are thus diverted from the intestine (their normal destination), the manufacture of bile by the liver is tripled and intestinal synthesis of

cholesterol is increased ten-fold. Thus it is almost impossible to regulate the amount of cholesterol in the blood merely by manipulating the diet. The body has its own regulatory mechanisms, curbs and controls.

Average values of blood cholesterol, therefore, have a wide range, much wider, for example, than the normal amount of hemoglobin, salt or sugar in the blood. A recent study of over 2,000 employees (presumably healthy) by the Metropolitan Life Insurance Company using automated equipment bears this out. Average cholesterol values for males were higher than for females below the age of 45 but the reverse was true at higher ages. For both sexes average values generally advanced with age with anywhere between 150 to 300 being "normal" and, in some instances, figures as high as 347 would be considered merely as "high average" rather than abnormal. A modern textbook lists the average values of cholesterol from 150 to 250. At the Massachusetts General Hospital the "normal values" are placed between 150 and 280.

To add to the complications of measurements, the amount of cholesterol that you have in your blood at any time will vary not only with age and diet but also with stress. Not long ago a group of doctors at the Navy Medical Neuropsychiatric Research Unit at San Diego, California, studied the blood of a team of sailors who had successfully completed a "stressful" 16-week Navy Underwater Demolition Training Course. These doctors placed the "normal"

range between 173 and 244 but individuals, upon repeated testing, showed variations in their own figures of eight to 20 percent of their averages.

In other words, a normal "average" man may have a reading of 200 on one day and 240 the next, and the 40-point difference would not reflect improvement or worsening but would simply be an average range for that person. Thus, the person who follows his blood cholesterol levels (like stock market reports), delighting in a two-point loss, or being depressed by a six-point gain, completely lacks any understanding of the nature of his blood cholesterol.

Nevertheless, in spite of the intricacies of the problem, there is enough evidence to suggest that true "hyperlipidemia" is related to hardening of the arteries and, for most of its victims, is a real threat to health.

Something should be done about it. But what?

First, never be satisfied with a

single blood cholesterol test. To undertake any sort of treatment schedule without several confirming tests may be foolish—if not hazardous. Not only do individuals vary within themselves, as has already been pointed out, but different laboratories vary with each other in technique and range of normality.

Second, keep the diet low in *calories*. A low calorie diet is usually a low cholesterol diet. Keep your weight at average or below average figures. To start a so-called low-cholesterol diet in your 80s is nonsense unless you plan on breaking the track record for longevity. If you get to 80-plus on what you've been eating (and enjoying) there's absolutely no point in changing your diet.

Third, consult your doctor about medicines. There are two drugs currently available (sodium dextrothyroxin and clofibrate) that can lower cholesterol in certain cases. Other anti-cholesterol drugs are currently "on the drawing board" and may be released by the Food and Drug Administration when their effectiveness and safety are assured.

Finally, don't become a "diet-nut" and don't panic because of some scare article that you may have read. No manufacturer of any anti-cholesterol medicine is still allowed by the Food and Drug Administration to claim that the lowering of cholesterol actually *prevents* hardening of the arteries or increases life's span. Keep thin, exercise regularly and check with your own doctor for any new developments. ■



For further reading

"Framingham P.S.—Fat in Food May Not Count." MEDICAL WORLD NEWS. September 11, 1970. Pages 15-17.

GARBAGE: a new raw material?

Can our maelstrom of refuse be re-used? You'd never know it in some of its new disguises.



By Barbara Ford

STEAM IT, BAKE IT, CRUSH IT, shred it, melt it, heat it, water it, shake it, mix it, compress it, plant it, filter it, spray it, extract it. "It," in each of these technological processes, is waste—the once-drab material from which scientists are now making a host of useful products, old and new. A growing number of these pollution experts claim that the best thing we can do with waste is recycle it back into the process that produced it or re-use it as a different product.

Either way, waste reclamation has some very attractive features: it gets rid of the waste, it gets rid of the pollutants often produced by dumping or conventional incineration—and it may even produce revenue.

No one is naive enough to believe we can reclaim *all* the waste we discard, but almost everyone involved in antipollution technology believes we can reclaim far more of it than we do. In Europe, always more re-use conscious than the profligate U.S., some 50 percent of waste paper is recycled back into the paper-making process. We reclaim only 20 percent—60 percent during World War II. Paper is generally conceded to be the leading contender for re-use but waste metals and glass are coming in for a good share of attention, too. Even messy waste like slag and fly ash can be economically re-used.

Fly ash, slag, glass, metal and paper are all solid waste, on which much of our reclamation efforts are focused at present (President Nixon

called for a concentration of Federal research funds in this area early this year), but ingenious processes to re-use and recycle liquids and even heat and air pollutants are also being developed. But let's look now at waste solids—our most visible waste pollution problem. Paper, our most valuable waste solid, makes up a whopping 60 to 70 percent of urban refuse. Paper is actually cellulose, a highly versatile material as some of the new uses being developed for waste cellulose indicate. Here is a grab bag of technology now being used to reclaim paper:

- In Pittsburgh, U.S. Bureau of Mines chemists have turned ordinary municipal refuse, minus metals and glass, into a low-sulfur oil. They do it by heating and shaking the refuse in a big stainless steel pressure cooker while adding carbon monoxide. The carbon monoxide and steam react to form active hydrogen, which converts 90 percent of the waste into oil. Next step: gasoline.

- Dr. A. O. Converse of Dartmouth College described a method for making sugar out of paper-rich refuse to the Northeastern Regional Antipollution Conference held at the University of Rhode Island in Kingston this summer. First developed during the sugar-shortage days of World War II, it involves adding water to refuse from which the metals and glass have been removed, then evaporating the moistened cellulose. Two hundred and fifty tons of refuse yield some 75 tons of sugar at about the same cost it would take to make sugar from molasses.

- Refuse with a high paper content has also been turned into a protein-rich animal food by General Electric's Dr. W. Dexter Bellamy,

Waste paper like this has been turned into a high-protein animal food by GE's Dr. W. Dexter Bellamy, shown here with test tubes of biomass produced from paper.



Conventional low-temperature incineration of hand-separated municipal waste produces unwieldy piles (top) of cans, ash, charcoal, iron and stones, among other residue. Most of it is disposed of as landfill. New IITRI method of high-temperature incineration converts non-separated refuse (large pile, right) into small pile of "urban ore" which can be turned into usable products such as filter pads and abrasive agents. IITRI says value of products recovers disposal cost.



who did it by letting heat-loving bacteria digest the cellulose in a high temperature "digestion tank." The bacterial action produces a bland "biomass" which is given a form and flavor animals like.

• At St. Regis Paper Company's Technical Center in West Nyack, New York, researchers have produced a grayish-brown paper suitable for printing and a cardboard that might make a good wallboard from ordinary garbage. The conversion process, which is still in the laboratory stage, might be a profitable way for a town of at least half a million population to reclaim its paper, metals and glass, according to Dr. Ed

Arnold, manager of Research and Development.

• Refuse treated with heat and water makes a fine compost, or soil conditioner, Raymond Regan of Manhattan College, N.Y., told the Northeastern Regional Antipollution Conference. He has devised an equation giving the amount of moisture needed for various kinds of refuse—the more paper, the more moisture.

Once paper is removed from municipal refuse, the most usable materials it yields are glass and metal. One big problem: separating the metal and glass from the paper. A number of new techniques are being developed to do the job, the most

promising at the U.S. Bureau of Mines' pilot plant in College Park, Maryland, where metals are separated from glass and other refuse mechanically. In most reclamation projects, however, hand sorting—a messy, unhealthy, expensive practice—is still the rule. Once separated, waste glass and metal have a number of uses. Among them:

- A small percentage of waste glass—it now varies from 5 to 10 percent but may eventually go higher—can be used in making new glass.

- Waste glass also makes a good substitute for aggregate in asphalt (they call it 'glasphalt'), as well as a component of bricks and other building materials, according to John H. Abrahams Jr., of the Glass Container Manufacturers Institute, Inc. "Research has already developed use for *all* waste glass," he told the Northeastern Regional Antipollution Conference. "The problem now is getting the glass." Member companies of the GCMI have begun programs for buying back used bottles (usual price: one-half cent apiece) based on a successful pilot program in Los Angeles.

- A similar retrieval program has been launched for aluminum cans by both Reynolds Metal and Kaiser Aluminum, both of which pay 10 cents per pound. The reused aluminum is recycled back into the can-making process, an operation that offers no problems when the cans are all-aluminum. Combination cans—those with steel sides (usually tin-plated) and an aluminum top are unusable.

- All-steel cans look like a good retrieval bet, too. In a recent test at National Steel Corporation's mill in Weirton, West Virginia, 750,000 tin-free steel beer cans and a number of old cars were dumped into a basic

oxygen furnace together with molten iron. After a half-hour, 300 tons of sheet steel emerged ready to be made into steel products. It's estimated that we discard about 65 billion tin-free steel cans each year.

- Junk cars, one of our biggest waste metal headaches, are being shredded into scrap and mixed with a plentiful but presently unused ore, taconite, in a promising U.S. Bureau of Mines project. When both are heated together in a kiln, the process turns the non-magnetic taconite into a magnetic substance that then responds to methods for separating iron from rock. At the same time the scrap itself oxidizes. Both metals are usable in their new form.

In most of these processes, sorting can make the difference between an economical operation and an uneconomical one, but some new solid waste technology evades the sorting problem. At the Northeastern Regional Antipollution Conference, Paul A. Carver of Charles A. Maguire and Associates enthusiastically reviewed Japan's new high-density waste compaction system, which can squeeze non-separated municipal garbage into a package 10 times smaller than its original size. After being dipped in asphalt and wrapped in chicken wire, the yard-long cubes are deposited in landfill sites and covered with topsoil.

"You can sit on the cubes, stand on them, eat lunch on them," Carver told his audience of engineers and chemists. "And I could work at the plant in the suit I have on."

Several 150-day tests run by the Japanese Department of Health indicate that biological and chemical reactions of the organic material in the garbage is sharply curtailed as a

result of the compaction, notes Carver. In particular, the tests show that the generation of gases normally produced by decaying organics is almost completely halted. Settling, another possible danger, appears minimal—one third of an inch on a 15-foot wall of cubes. The prime advantages of the method, says Carver, are efficiency and cost savings, plus cleanliness, flexibility and low noise.

Is this the answer to the U.S. garbage disposal problem? A similar system is being installed for the city of Boston but some of Carver's professional colleagues expressed doubts about it. "I don't like leaving the garbage untreated," one remarked later at dinner. "What happens to it in 10 years? Or in 50 years?"

Another process for treating non-separated solid waste has been devised by the Illinois Institute of Technology Research Institute in Chicago. It is a high-incineration system (2800°F) that converts solid waste into what IITRI calls "urban ore." The glass and metal (organics are consumed) in the melt separate from one another, the metal settling to the bottom of the furnace and the glass rising to the top as slag. The metal can be used in making filter pads, abrasive agents and iron castings, while the glass goes into fiber, beads, sewer pipe and structural tile. The cost? IITRI says the value of the products made from urban ore would recover the costs of refuse disposal.

Non-separate solid waste makes a fairly good fuel, too. A new electric plant at Hogdalem, a suburb of Stockholm, Sweden, will burn all the municipal refuse trucked to it to generate electricity. Since refuse is a low sulphur fuel, the plant will produce little pollution. Experts there

figure that Stockholmers discard some 650,000 tons of garbage per year from which some 16 million watts of electricity can be produced—more when two new furnaces are added. A similar plan will be tried soon in St. Louis, Missouri, where Union Electric, the local electric utility, will burn municipal waste with fossil fuel in a new government-financed plant.

Novel processes to reclaim other kinds of solid waste are also in the works. Among them:

- Old rubber tires will yield oil and gas in a new plant being built by Firestone Tire and Rubber Company in Akron, Ohio. Earlier, Firestone and the U.S. Bureau of Mines cooperated on a project that produced as much as 140 gallons of liquid oil and 1500 cubic feet of heating gas from one ton of junk tires.

- Sewage sludge, the solid leftover after sewage is treated, can be converted into a syrup-like molasses rich in food values in a process developed by Foster D. Snell, Inc. It involves heating the sludge and adding sulfur dioxide, thus dissolving part of it and leaving a treated filtrate containing protein, carbohydrates, vitamins and salt. It's suggested, like other food products retrieved from waste, as an animal food.

- Almost any kind of inorganic aggregate, from fly ash (the talcum-powder-like substance produced by burning coal) to the residue of high-temperature incineration, can be turned into bricks in the Tech process, invented by T-A Materials, Inc. Workmen dump the aggregate into a hopper, add a little water, a dash of cement and a few chemicals, then stir. The mixture is fed into a press which makes bricks and building blocks cheaper than clay bricks.

The technology exists to convert much of our waste to useful products, but who is going to pay for it?

- Coal fly ash can also be placed in rubber tires, where its presence significantly improves traction and skid resistance, the U.S. Bureau of Mines reports. As much as two pounds of ash per tire can be added without noticeably affecting the wear properties of the rubber.

- Ugly deposits of slag, the waste produced by steel mills, has been turned into an asbestos-free fireproofing spray by United States Mineral Products. Asbestos sprays are strictly regulated in New York City, where use of them is said to have harmed the lungs and gastrointestinal tract.

The technology obviously exists to retrieve much of the contents of our wastebaskets and garbage cans as well as the by-products of industry, but who is going to pay for the retrieval? At the Northeastern Regional Antipollution Conference, several industry spokesmen painted a gloomy picture of the costs of reclamation. "In general, if you want to recover something, it costs you twice as much as it does to destroy it," pointed out G. V. O'Connor, director of development for Monsanto Biodize Systems, an offshoot of Monsanto Chemical Company that develops and installs pollution control systems for industry. Industry, other speakers indicated, is not eager to pay the bill. But some noted that if strict government controls are instituted for waste disposal, it may be cheaper and cleaner to retrieve salable products from waste rather than incinerate it or treat it. Relatively pollution-free disposal is not cheap.

Still, government subsidies may be

necessary for some reclamation processes. "I think the capital investment for this process is too high," says Herbert R. Appell, one of the Bureau of Mines chemists who retrieved oil from garbage. "It needs some sort of subsidy."

A number of participants in the conference indicated that the U.S. householder could make the retrieval of waste cheaper and easier by separating his own solid waste at the household level, much as millions of U.S. citizens did during World War II. Home separation would cut down what is often the biggest expense involved in reclamation of solid waste. Dr. James E. Etzel of Purdue University recommended recently that every household have its own small hydropulper, a machine that grinds up glass, wood and bones to sand-sized particles and reduces metal to golf-ball-sized chunks. No hydropulpers are yet in operation at the household level, but pilot household separation projects are now going on in a few communities around the nation.

"The cheapest thing to do with waste, of course, is nothing," G. V. O'Connor told his audience of chemists and engineers at the Northeastern Regional Antipollution Conference. "But in the end that may turn out to be the most expensive thing of all." ■

For further reading

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Solving the mystery of The Street of the Dead

by L. Sprague de Camp

IN A.D. 1521, Hernando Cortes and his army vanquished the Aztec city of Tenochtitlàn and built a new town, Mexico City, on its ruins. The march to Tenochtitlàn had taken the Spanish conquerors through the ancient remains of Teotihuacán (pronounced teh-o-tee-wa-KAAN), a city which contained two huge pyramids, for many years in abandoned ruins and covered with trees and scrub.

After the Conquest, Spanish and Hispanified Indian chroniclers went back to the pyramids and questioned the defeated Mexicans who lived nearby about the history of Teotihuacán. The Mexicans had plenty to tell.

To begin with, the name of the city

meant "abode of the gods." Some said that Teotihuacán had been built by gods; others, by giants.

Before the rise of the Aztec Empire, said still others, a race of mighty builders called Toltecs had ruled central Mexico. Teotihuacán had been one of their capitals—perhaps the legendary Tollan. Another tale told how the gods Nanahuatzin and Teuciztecatl had thrown themselves into the sacred fire and emerged as the sun and the moon respectively. The pyramids marked the sites of these gods' self-sacrifice and were, therefore, called the Pyramid of the Sun and the Pyramid of the Moon.

A mile-long avenue, lined by smaller ruins, connected the two pyramids. Believing that these smaller



Temple of Quetzalcoatl (also called the Temple of the Frog) means "feathered serpent," and this picture shows why the ancient temple received its name. The feathered serpents here alternate with heads of Tlaloc, the rain god.

structures were the tombs of priests and chiefs, the Aztecs called this avenue the *Micoatl* or Street of the Dead. The site still had religious significance. The late Moctezuma, slain by his own people during a battle, had once performed religious rites there.

In the centuries after the Conquest, however, it became plain that the Aztecs had not really known anything definite about Teotihuacán. In fact, the city had already lain in ruins for half a millennium when the Aztec Empire first arose and the Aztecs began keeping records. These records were pictures on sheets of deerskin or agave paper, like comic strips without written words.

In the 19th century, pioneers in the youthful science of archaeology began

to investigate Teotihuacán. Prominent among these was Zelia Maria Magdalena Nuttall Pinart (1857-1933). She achieved much by finding and deciphering Aztec picture-manuscripts and by collecting and describing little clay figurines from various parts of Mexico, notably from Teotihuacán. Whereas the figurines from older sites are merely crude, generalized images of human beings, those from Teotihuacán take on the definite forms of the gods of the ancient Mexican pantheon.

Following her, a pioneer Mexican archaeologist, Leopoldo Batres, became "Guardian of the Monuments" and turned his attention on the Pyramid of the Sun at Teotihuacán. Around 1905, thinking that this pyra-



Pyramid of the Moon (above left) at Teotihuacán is the north end of the Street of the Dead (Micoatl). A view of the street (above) taken from the Pyramid of the Moon looking south shows the Pyramid of the Sun on the left. Both pyramids originally had small temples at their peaks, which have disappeared. Pyramid of the Sun, the largest of the two, was originally about 243 feet high. Comparative drawing at left shows its size in relationship to the Egyptian Pyramid Cheops of Khufu at Giza, over 480 feet.

mid was too far gone to restore and believing that, if he peeled off the outside, he would find a buried temple, Batres began dismantling the pyramid. When the monument had been partly demolished without finding any temple, somebody in authority halted the destruction and ordered Batres to put the pyramid back together. This was done in hasty, slipshod fashion, so that the pyramid now bears only a vague, general resemblance to its original appearance.

Archaeological work continued at Teotihuacán during the succeeding decades. In 1962-64, under the direction of Dr. Ignacio Bernal, the Mexican government undertook to clear, consolidate and restore the ruins and to erect a well-planned local museum.

The main axis of Teotihuacán is

the straight, mile-long Micoatl or Street of the Dead, a splendid ceremonial avenue running approximately north and south. The three main structures fronting on it are the Pyramid of the Moon at the north end; the Pyramid of the Sun, about 750 yards south of the Pyramid of the Moon and standing on the east side of the Micoatl; and the Ciudadela or Citadel at the south end of the Micoatl, also east of the avenue.

The Pyramid of the Sun is a little larger than the Pyramid of the Moon; but, since the latter stands on higher ground, its top is higher. On their tops, both pyramids originally bore small temples, which have now disappeared. With its temple, the Pyramid of the Sun was originally about 246.7 yards on the base side and about 243 feet

high. (The corresponding measurements for the Great Pyramid of King Khufu at Giza were about 247.3 yards and 480+ feet, respectively.)

During the early decades of this century, there was much pseudo-scientific speculation about whether the ancient Mexicans and Peruvians had obtained their ideas for pyramids from the Egyptians. Some said that ancient Egyptian ships had sailed to the New World and taught the primitive natives the art of pyramid-building. Others asserted that the pyramid-building custom had spread around the world from west to east and had crossed the Pacific instead of the Atlantic Ocean.

From what is now known, however, these ideas can be summarily dismissed. The Egyptians had no ocean-going ships and, moreover, stopped building pyramids well over 1,000 years before the erection of the great piles at Teotihuacán. Whereas the Egyptian pyramids were purely tombs, the pyramids of the ancient Americans—in Mexico, Guatemala and Peru—were bases for temples, although they might sometimes bury an eminent chief or priest beneath one as a special honor.

As with the ziggurats of ancient Mesopotamia, the likeliest explanation of the American pyramids is that they enabled the priests to get closer to the gods in heaven, so that the latter could better hear the prayers and flatteries addressed to them. The fact that these various lands produced monuments of much the same shape means only that, when architecture is still primitive, a pyramid is the only kind of really high building that can be put up without imminent danger of falling down.

Around the square plaza in front of the Pyramid of the Moon stand a

number of smaller, truncated pyramids or pyramidal platforms; in the whole area of Teotihuacán there are about 50 of these platforms. Along both sides of the Micoatl, for its entire length, rise the remains of other buildings, which have been named for the decorations uncovered in modern times: the Palace of the Quetzal-butterfly, the Jaguar Temple, the Building of the Feathered Shells, and so on. Some of these edifices are partly underground, because later structures were built on top of them.

The citadel at the southern end of the Micoatl was so called by the *conquistadores* because the square, walled enclosure looked to them like a fortress. The enclosure is a square about 1,300 feet long on each side, bounded on each side by a wall—or rather, by a platform 50 to 100 yards wide, surmounted by a row of three or four truncated pyramids. It was, however, a religious structure and not a fortress.

In the midst of the enclosure stood a hill of rubble. When excavated, this proved to be the remains of two pyramids, one built on top of the other. When they decided to enlarge one of their pyramids, the ancient Americans sensibly did not demolish the old pyramids but simply added the desired number of courses of stone or brick to its exterior.

From the feathered serpents that decorate the western face of the smaller one, the pyramid is called the "Temple of Quetzalcoatl." This name means "feathered serpent" in the Náhuatl tongue spoken by the Aztecs and still used by over a million Mexicans. "Quetzalcoatl" was the name of a god and a tenth-century Toltec priest-king.

The Citadel, the pyramids and the supposed palaces along the Micoatl

were all built for religious or governmental purposes. There dwelt the priests, the nobles and the chiefs. The common people lived in huts of adobe and thatch, on streets which, laid out in a grid pattern, spread across the plain. Many decades of excavation and study will be required to learn all that can be known about the Teotihuacanos from these remains.

When the 16th- and 17th-century literature about the Aztecs—mostly in Spanish, but some in Romanized Náhuatl—was assembled and compared, it was found to tell a fairly coherent story of the Aztec Empire. The Aztecs (or Azteca or México, as they called themselves) were one of the tribes of wandering barbarians, collectively called Chichimecs, who had overthrown the Toltec Empire and then built their own civilization on its ruins. During the 14th century of the Christian Era, the Aztecs had settled on an island in the wide, shallow Lake Texcoco, which then occupied much of the Valley of Mexico. Their city, Tenochtitlán, grew to a kind of Amerindian Venice, with all parts interconnected by waterways. (Since the Conquest, the lake has almost entirely dried up.)

By the time of the Conquest, the Aztecs had established a shaky control over most of central Mexico. But most of the subject tribes, resenting the draft of their youths and maidens for sacrifice, were only too willing to side with the Spaniards.

Before the Aztec Empire, said the chroniclers, the Toltec Empire had flourished until overthrown around the 12th century by the Chichimec invasions. The Toltecs, too, had a detailed dynastic history; but this, in the form in which it has come down, consists mainly of myth and legend. The

idea long persisted that Teotihuacán was the Toltec capital of Tollan, where the great Huemac and his successors had reigned. During the last 30 years, however, much has been done to straighten out the history of pre-Aztec Mexico. In 1941, the Mexican archaeologist Jiménez Moreno convinced his colleagues that the Toltec capital, the Tollan of the chronicles, had been, not Teotihuacán, but Tula, 40 miles northwest of Teotihuacán. At Tula, amid the ruins of the city, rises a flat-topped pyramid of moderate size. This pyramid is remarkable for the colossal, columnar statues of warriors, each 15 feet tall, standing on the flat top. In Toltec times these statues upheld the roof of the temple of Quetzalcoatl.

Radiocarbon dating and the partial decipherment of some genealogical manuscripts of the Mixtec people, who lived around Oaxaca in the South, further helped to solve the puzzle. Then it transpired that Teotihuacán had flourished, not parallel with Tula, but *before* it.

Who the original Teotihuacanos were, what they called themselves and their city, where they came from, and what language they spoke are unknown. Not one scrap of authentic historical knowledge about them has come down. What we know about them is what can be safely inferred from archaeological study.

There is, however, no reason to doubt that the Teotihuacanos were physically like the other Mesoamericans: rather short of stature, copper-hued, with small hands and feet, broad heads and a tendency to hooked noses and retreating chins and foreheads. Their customs and religion seem to have been much the same as their successors, the Toltecs and the Aztecs.

"If civilizations be defined as . . . cities, writing and metals, Teotihuacanos were one-third civilized."

Teotihuacán took form as a civilized center about the second century B.C. Some archaeologists think that this growth was stimulated by the influence of one of the more easterly Mexican nations, such as the Totonacs or the Olmecs, whose cultural rise began a little earlier. During the next few centuries, the town grew to a large but unfortified city, and the great pyramids arose.

We can be sure that the Teotihuacano religion was much like that of later peoples. Their statuary clearly shows deities like Quetzalcoatl and the water goddess Chalchiuhtlicue, who were still worshiped at the time of the Conquest.

An idea of the Teotihuacano culture can be gained from the things that later Mesoamericans had, which the Teotihuacanos did *not* have. The later Mexican Indians made much use of gold and silver and were beginning to use copper at the time of the Conquest, but the Teotihuacanos were altogether innocent of metals. Like the Aztecs but unlike the Mayas, they did not have a developed system of writing, although certain glyphs in their decorations are thought to have had symbolic meanings. Hence, if civilization be defined as the combination of cities, writing and metals, the Teotihuacanos were only one-third civilized.

While the Teotihuacanos had a set of number symbols, they did not, as did the Mayas, have a symbol for zero. Teotihuacán did not have the memorial steles so common in Mayaland. Neither did it have the corbelled vault or the ball court, both widely

used throughout Mexico later. (See "Tlachtli," November 1970, page 26.) The Teotihuacanos did not smoke pipes and cigarettes, as did the Aztecs; if they knew tobacco, they used it only as a medicine. They lacked the bow and arrow, which first appeared in Mesoamerica during the Chichimec invasions.

About the eighth century (estimates range from A.D. 650 to 900) Teotihuacán fell. A wave of barbarian invaders—possibly the Toltecs' forebears—overthrew the Teotihuacano state and burned the city. The increasing dryness of the land, together with the improvident deforestation of the surrounding hills, may have helped to weaken Teotihuacán. To judge from archaeological remains, some Teotihuacanos fled to Azcapotzalco, southwest of Teotihuacán and west of Lake Texcoco, and to Xochicalco, 40-odd miles south of Mexico City.

A century or two after the fall of Teotihuacán, the Toltecs settled at Tula and built a new capital there. Their state or empire flourished about from A.D. 900 to 1150, to fall in its turn before other barbarians.

There was nothing inherently mysterious about the Teotihuacanos. But, because nobody took the trouble to preserve their history during the two violent interregna that followed the fall of the Teotihuacano and Toltec civilization, it vanished forever down the pitiless gullet of time. ■

For further reading

MEXICO BEFORE CORTEZ: ART, HISTORY, LEGEND. *Ignacio Bernal. Doubleday & Co., Inc. 1963.*



An ocean full of medicine

People have sought ocean "cures" for centuries, but now scientists are discovering just what valuable medicines exist in the depths.

by William and Ellen Hartley

WHEN THE GREAT American boating public launches into another season next April, it will be enjoying itself immersed in the greatest potential drug store known to man. We've known about it all the way back to pre-history; but until recently no one has stepped up to the counter. The source of probable medical supplies is, of course, the oceans of our world.

The halogen, iodine, was identified in 1811 by Bernard Courtois. In its most primitive form, it comes from the ash of certain types of seaweed. But as early as the era of the Phoenicians (and probably much earlier) man looked to the sea for medical aid. He didn't know exactly why ocean products helped his ailments; but he recognized that they had a beneficial effect.

As recently as 1930, some individ-

Photos: Wometco Miami Seaquarium

Puffer fish skin, intestines contain tetrodotoxin, valuable medicinally, but lethal if the fish is not prepared properly for eating.

uals still went to the ocean shores for the "cure." Newport, Bar Harbor, the great seaside spas of Europe had curative as well as social implications. Favorable results were probably psychological to some extent; but there isn't much doubt that shore visitors ingested helpful ingredients from their sea food.

Cod liver oil was used as a vitamin source long before man knew what vitamins were. In his survey of a Marine Technology Society symposium held at the University of Rhode Island at Kingston in 1967, Dr. Ara Der Marderosian (Philadelphia College of Pharmacy and Science) notes that classic drugs from the sea include agar, protamine sulfate from salmon, certain alginates and a number of other products. Agar comes from certain types of seaweed, and inhibits the growth of some viruses. Protamine is a basic protein. Alginates are sometimes used in surgical dressings or to form a gel.

But Dr. Ara Der Marderosian, who is widely regarded as one of the world's top men in the study of drugs from plant or animal sources, ob-

serves that, "Thousands of marine organisms are known to contain biotoxic substances and less than one percent of these have been examined for their pharmacological activity." It may be a cheap joke, but in this case what we *don't* know may hurt us.

Extensive studies of drugs from the sea are being conducted at the Osborn Laboratories of Marine Sciences, New York Aquarium; the University of Miami's Institute of Marine and Atmospheric Sciences; and perhaps half a dozen institutes elsewhere within the United States. Despite this worthy activity, there are fewer than 40 senior specialists in marine pharmacological and physiological research.

As one cure for an untenable situation—after all, some 70 percent of the earth is covered with water and water organisms—Senator Warren G. Magnuson (D., Washington) has placed a bill (S.1588) before Congress to establish a National Institute of Marine Medicine and Pharmacology.

The bill is still limping through the legislative mill, but Senator Magnuson told *Science Digest's* writers that there is "wide support among scientists for this legislation." This is easy to understand. Although relatively few scientists are working in these highly specialized fields, many recognize the importance for continuous marine biochemical and pharmacological studies. They have shown much promise in alleviating the diseases of mankind.

What do we expect to get from the sea, sea organisms or sea vegetation? Most of the following views are a synthesis of those of Drs. Ross F. Nigrelli and George D. Ruggieri,

Sea cucumber is source of important research extract, holothurin.



S.J., (Osborn), Dr. Ara Der Marderosian (Philadelphia) and Dr. Charles E. Lane (Miami). In their papers or conversations, they refer to a broad spectrum of scientists in America and foreign countries. Unfortunately, space limitations prevent full crediting. It is appropriate, however, to mention Dr. B. W. Halstead of the World Life Research Institute in Colton, California.

Dr. Nigrelli and his associates have been working with *holothurin*, an extract from sea cucumbers. No one at this time even pretends that *holothurin* is a cancer remedy for man—but it does inhibit the growth of tumors in mice. It is also a cardio-tonic agent that may even be better than digitalis. And it blocks nerve conduction without harming the nerves.

In the cancer-killing department, the female sea worm or *bonellia* is interesting. It produces a hormone, *bonellinin*, that inhibits growth. Tested on sea urchin eggs and on cancerous cells, it has stopped their growth entirely. Since it has this peculiar quality, it has obvious implications for cancer control. Scientists carefully point out that even though these substances may be unsuitable for use in man, they may serve as chemical models for synthetics.

There's a possibility that an extract from common clams may have cancer-curing properties. (This is no reason to go in for a diet of clams. Much remains to be learned about their antitumoral activity.)

In a practical sense, a marine plant produces a substance called *cephalothin*. It works somewhat like benzyl penicillin, but is active against certain penicillin-resistant bacteria. Lilly Pharmaceutical puts it out as a

semisynthetic called "Keflin."

A product called "Digesan" is marketed by Takeda Pharmaceutical Industries, Ltd., in Japan. This comes from an algae and is useful against parasitic worms. Marine algae, in fact, may become one of our best sources of antibiotics. In the plant family, kelp contains an ingredient that is a virus inhibitor. Sodium alginate from marine vegetation has fully a dozen uses. One is that it knocks out radio-strontium from the human gastrointestinal tract. It's produced in America as Kelgin (Kelco Company, New Jersey) and Manucol or Manutex in England.

It is comforting to realize that Strontium 90, considered one of the most hazardous of all long-lived nuclear fission products, can be removed from the human system without upsetting regular body function.

When you sponge down your windows, you may be doing it with an antibiotic. The analogy is exaggerated, of course, but many types of sponges—fresh to dried—have antibiotic properties.

One thing pointed out by Dr. Nigrelli and his associates is that seawater itself has antibiotic substances. Man has always known this in a vague, atavistic way—long before the word "antibiotic" came into the language. Wounded men on the war vessels of early years were liberally dosed with seawater. The idea was that salt somehow cleansed abrasions and other injuries. We now have evidence that more than salt is involved. There are more than 1,400 types of bacteria in ocean water; and where bacteria are found, anti-bacterial agents are also present.

Toxic materials from the sea or from sea organisms probably have

the most value to man. Most of our drugs are basically poisonous. Common aspirin is a poison if taken in excessive doses. Medical science is alerted when a lethal material is isolated, because a modification or a synthetic substance may be tremendously beneficial to man.

Dr. Charles E. Lane originally went to Florida to find out how shark carcasses could be turned into fish meal. He then began working on isolation of the poison in the Portuguese man-of-war, a jellyfish with poisonous tentacles. It isn't deadly poisonous as is the sea wasp of the South Pacific (*Science Digest*, August 1970, p. 24), but you don't forget a meeting with a man-of-war.

Dr. Lane never forgot his encounter. "We were swimming off a Florida beach," he recalls, "and the entire family was thoroughly stung. I was disturbed to realize nobody knew anything about the nature of the animal or the material that was responsible for our agony."

Shortly thereafter, Dr. Lane began his studies at what is now known as the Rosenstiel School of Marine and Atmospheric Sciences, University of Miami. It was a long, tedious job to separate the *nematocyst* or stinging structure from the tentacular material, but Dr. Lane eventually managed to do so—getting stung so often that he now has "a pretty good sensitivity to it." He says, "I almost have to stay out of the laboratory when the material is being prepared."

When he started his man-of-war research, the "poison" was a homogenate prepared from the whole animal. Realizing that this crude mixture contained other ingredients, Dr. Lane worked out a system of separating the stinging structure from the

tentacles with the help of a mild enzyme. He was thus able to produce pure man-of-war toxin.

Parenthetically, guided by Dr. Lane's experiments and preparing pure sea wasp toxin, the Australian Serum Laboratory has recently developed a serum for the deadly sting of the sea wasp, another member of the Coelenterata family. Dr. Lane suspects that the chemistry of the sea wasp, another jellyfish structure, and the man-of-war may be quite similar.

However, the man-of-war just drifts along with the current and has no effective way of administering its deadly toxin, except in a chance encounter. The sea wasp, swimming by pumping in typical jellyfish fashion, has photo receptors and, moving toward the shadow it perceives, literally stalks its prey.

Dr. Lane has found that man-of-war toxin inhibits membrane activities, checking nerve conduction. It may also provide an ulcer cure. Dr. Lane says, in genial slang, "When you've got a material of this type going for you, its practical use as a clinical tool seems almost boundless."

"There are all kinds of human maladies that involve defects in cellular function. If we can turn off cellular activity, the speculation is fascinating. But I think now that this is a problem for clinicians rather than those of us in fundamental biochemistry. We've been giving them the tools. Now let them use them."

It isn't that easy, of course, and Charles Lane would be the first to

Portuguese-man-of-war toxin gives a powerful sting but may someday be the source of a cure for ulcers.



admit it. He has a vest pocket attitude toward the use of research money; but (presumably) he would agree with Dr. Ara Der Marderosian that it takes about seven million dollars to get a new medication out of the laboratories, into pharmaceutical production, and into good old Doc Jones' office. Moreover, biomedical research is not done in a hurry. Dr. Lane has spent more than 15 years on his man-of-war studies.

There are many other potential or studied drugs from the sea—so many, despite financing hardships, that a full listing would look like the Yellow Pages in a city phone book. A few are mentioned in the following paragraphs.

Can one imagine a nerve poison 160,000 times more effective than cocaine in blocking nerve conduction? One exists. The substance is known as *tetrodotoxin*, found in the puffer fish and more recently in the California amphibian newt, *taricha torosa*. Dr. Ara Der Marderosian has called it, "... the most spectacular single substance of pharmacological interest isolated and characterized in the past few years from marine sources. . . ."

It has been used in *small* doses to relieve suffering in terminal cancer, and to reduce muscular spasms. The Sankyo Company (Japan) and at least one American firm have been producing it.

Other neurotropic agents (those with a selective affinity for nerve tissues) include *saxitoxin*, *mytilotoxin*, *murexine* and several others. Almost all are frighteningly toxic materials, but so is ingested iodine. The great hope is to harness their properties in therapeutic form.

Current research is a projection

of the long-term work started years ago. Thus, to borrow heavily from Dr. Ara Der Marderosian, there is continued interest in the hagfish hearts. This primitive fish has three hearts. Two are connected, working in unison. The third heart is independent from the others and synchronized by a chemical substance, working like an ideal chemical pace maker for the hagfish. (It may eventually do the same for man.) The hagfish may expand the knowledge of our own hearts, and it may also give us some knowledge of the immune system. The hagfish has no thymus gland, a small organ that triggers immunity to disease. Theoretically, there should be no hagfish. But something protects them: and grafts may lead us toward an understanding of the protective mechanism.

Dr. Ara Der Marderosian makes much issue of sea cucumber nerve toxins. To quote him directly (*Drugs from the Sea*, Rhode Island, 1967), he says that these toxins are interesting because they are capable of "freezing" nerves without damaging them, for possible post operative treatment of amputations.

In an overview of a complex, fascinating field, one has to consider Dr. Ara Der Marderosian's quote that "fully four-fifths of the earth's animal life (representing over 500,000 species in 30 phyla) lives in or on the water."

Man came from the sea. In his infinite stupidity, he has almost forgotten it as a source of life and health and is contaminating it at an ever increasing pace. Now, with the help of a handful of devoted scientists, he is hopefully beginning to recognize the sea as his best friend. ■

MIXED-UP GENES & PURE-BRED DOGS

10 things to check when you buy a pup

Dog breeders with good intentions have done considerable genetic damage to many of the most valuable dog breeds because of certain selective breeding techniques. The pug, for instance, has breathing problems because of being bred for its short, pushed-in snout.



Photo Trends

by Dean Lipton

PAM, A SMALL, affectionate, female Boston bull terrier puppy, and Ranger, a large and handsome male German shepherd, have one thing in common. Both are the victims of the absurd ends finally reached by selective breeding.

1 Beware of hip dysplasia.

Once the Boston bull was a numerous breed, but today it is seen far less frequently. It is a dying breed simply because breeders breeding for small size have so narrowed the female's pelvic area that fully fifty percent of all Boston bull puppies born today must be delivered through caesarean section.

Ranger's problem is of a different

nature. He is a cripple suffering from a bone disorder called hip dysplasia. The German shepherd deserves his popularity. He possesses a high order of canine intelligence, and under proper conditions, he is gentle enough to be a child's pet. At his best, he is the most versatile of working dogs. German shepherds were initially bred for sheep-herding, thus their name. But they have been successfully used in fields as far apart as police and military work and as seeing-eye guides for the blind. Hip dysplasia is a congenital disorder afflicting more than a quarter of this outstanding breed in the United States.

"The disorder involves the abnormal development of the ball and socket of the hip joint, resulting in a 'sloppy fit,'" says Dr. Gary Brown of the An-

imal Medical Center in New York City. "This painful condition can lead to osteoarthritis and abnormal function. We recommend, by the way, that dogs with this condition not be bred."

The insidious thing about it is that it cannot be detected in puppies even by experts using X-rays. When the dog grows older, an X-ray will accurately pin-point the disease, but by that time it is too late to do much about it. Hip dysplasia progressively cripples the animal until his hind quarters are no longer able to function adequately. Sophisticated breeding methods are spreading it through the breed.

2 Watch out for grotesque features.

Nor are these the only dogs to be wrecked by the breeders. Originally, the cocker spaniel was a wonderful bird dog, sturdy and intelligent, used to course out grouse, woodcock and other game birds. But that was before the breeders started to work on him for show and as a pet. His sturdiness has been bred out of him, and with it, his intelligence. He is sometimes skinny and sometimes overweight, according to the kind of master he has. The demands of the show people have caused the breeders to grow his ears to a grotesque length, far too long to get around in the brush. More than this his nerves have been shattered, and he is so hysterical that sporting men generally consider him a coward. Today, he is fit only for what he has become, a woman's plaything.

3 Bred for work or for show?

The cocker spaniel is only one of the many sporting dogs destroyed by the demands of the show room and peoples' desires for a pet. Some



Grotesquely short legs, long bodies and frequent back problems haunt the dachshund.

breeds can be divided into two distinct classes: those animals which are used in the field and those used for show. And the distinction is frightening to anyone who loves dogs. Many pointers, some setters, retrievers and large spaniels are still wonderful dogs when bred for the field. They have the muscle, the ruggedness, the stamina, plus that all-important quality in a field or work dog, intelligence. But the dogs of the same breed bred for show are another animal entirely. Their heads are too skinny, their flanks too heavy, and their lack of endurance and running ability makes them useless for field work, and to put it bluntly, they are dumb.

4 Know the history of the breed.

There is not even this division in some breeds. The beautiful Irish setter is seldom used for field work these days, nor is the once popular Gordon setter. Or take the astounding case of the French poodle, by long odds the most popular breed in the United States. It is not generally known but the French poodle was not always a pampered house pet. He has a proud history as a sporting dog—one of the finest retrievers ever known—which goes back beyond the Middle Ages. Archaeologists have unearthed Roman

bas-reliefs of the poodle carved during the first century. Even the way he is clipped is not some woman's idea of a joke but a hang-over from the time he was clipped in this fashion to enable him to negotiate thick brush and swim easily.

5 What is your purpose in buying a pup?

So far has the French poodle descended that the American Kennel Clubs don't even list him as one of the sporting breeds. Yet in England and Europe he is still used as a retriever. Fortunately, the process may be reversed in this nation. In the late 1950s, a group of sportsmen and women in Maryland began working the French poodle as a retriever. They found that unlike so many other breeds the breeders have not succeeded in destroying his intelligence. Furthermore, he still has the nose, memory, mouth and hunting desire necessary for a good retriever.

But, while the French poodle may turn out to be a happy exception, the lot of many other breeds is far from a happy one. The list reads like a *Who's Who* of famous dog breeds. From St. Bernard to dachshund, from the friendly little basset to the stately great dane, the story is everywhere the same. Breeding for show has weakened the St. Bernard's back which in turn has caused a clumsy, lumbering gait. It is doubtful if the show-bred St. Bernard could rescue anyone. More likely, he would be the one in need of assistance.

6 Know the potential defects of your pup's breed.

Like the German shepherd, increasing numbers of great danes suffer from hip dysplasia. While the basset does not have a congenital deforming disease, he might as well. For rea-

sons known only to themselves, breeders have bred into him short, twisted front legs which cripple the entire breed. Like the cocker spaniel, his ears are too long, again the result of excessive selective breeding. The dachshund was developed to hunt badgers. The work demanded a dog short enough to follow a badger into his den, swift enough to catch him, and powerful enough to fight and vanquish him. This was the profile of



Basset hound has all but been crippled by breeders seeking shorter legs, longer ears.

the dachshund as he used to be, but the breeders have turned him into a pale facsimile. He is thinner, longer, and so delicate that to use him as any kind of a hunting dog is simply out of the question.

Sometimes excessive selective breeding will change the nature of a dog as well as inculcate different physical characteristics, and probably the most tragic example of this is what has happened to the collie. This dog's very instincts have made him a fabled legend. Collie-type dogs are mentioned in the ancient chronicles of the early Roman Empire, and there



Great Dane was once a ferocious dog, but breeders have succeeded in developing a docile, loving pet. The Dane represents one of dog breedings success stories.

is a dog like a collie in Chaucer's *Canterbury Tales*.

They are the second most popular breed of dogs in the United States and have been popular in England for show purposes since the middle 19th century. Queen Victoria was so taken with the breed that she helped promote it, although it was a vastly different animal then. Still, it might have been far better if she had never seen a collie.

The collie got his start as a sheep dog. But the ones we see around our cities today would be useless on a ranch or farm with more than two sheep. For years, the animal used for most sheep work has been the border collie which the breeders have not yet gotten around to destroying. The reason some collie fanciers give for this is economic. They insist that the show-style collie is just too expensive for such utilitarian work. But the facts are quite different. An ordinary collie puppy of reasonably good stock can be purchased for as little as \$50; a two-year-old, for about \$200 or \$300. Two years ago the prices quoted in Scotland (where most border collies are raised for skilled sheep dogs) ranged from 250 pounds (\$600) to

1,250 pounds (\$3,000); and in one instance, an Argentine sheep rancher offered \$4,500 for a dog he particularly wanted. Demand for these wonderful dogs far outstrips the supply. Buyers come from every sheep-raising country in the world just to try to obtain one of these workers.

When we make a comparison between the two breeds, here is what we find. In the standard collie, specialized breeding to produce a narrow head has diminished his intelligence. His slender legs and narrow chest would not sustain him long on rough sheep terrain. The pencil-thin nose and mouth desired for show demonstrations would hardly enable him to protect a herd against predators. And most important, although he comes from a long line of sheep-herding ancestors, the instinct for this work is all but gone.

The border collie is strikingly different. His broad forehead denotes his keen intelligence. His sturdy legs and deep chest enable him to be on the move for hours without tiring. His blunt nose and mouth make him a worthy foe against all but the largest predators. But most important, his ancestors' old sheep-herding instincts

still flow in his body with full force. The border collie's saving grace has been that he has not been recognized as a show dog.

One look at the variegated breeds of domesticated dogs should indicate, if nothing else did, that the breeders are the heroes as well as the villains of the dog story. Without their work, the dog world would be much poorer than it is.

By the time man began domesticating the first dogs 10-12,000 years ago, multitudinous species of wolves, jackals, foxes and wild dogs roamed the wilderness. The fact that there were so many different kinds of dogs even at an early stage led to the belief that they developed from different wild doglike animals. However, it is generally recognized today that all domesticated dogs in breeds ranging from Pekingese to great dane were developed originally from wolves.

The Russian geneticist, Iljin, conducted a series of hybridization experiments in the 1920s. He pointed out that dogs and wolves were so close that they interbred freely producing fertile off-spring, the duration of pregnancy was identical in both species, as was the blind period in the young.

In 1954, another geneticist, Matthey, analyzed wolf and dog chromosomes, and then categorically stated that the wolf was the only ancestor of the dog. John Paul Scott, who is both a zoologist and a psychologist, after studying the question, decided that the dog has all the basic behavior patterns of the wolf. Others have pointed out that when a breed of domesticated dog such as the Australian dingo reverts to the wild state it adopts the habits of wolves and not foxes or jackals.

Now, it is obvious if all dogs were first developed from wolves, that there were some early-day breeders who knew or guessed a lot about the laws of heredity long before Mendel. There are innumerable examples of the yeoman work done by breeders from that time to the present. The many breeds of spaniels, setters and pointers were developed during the Middle Ages from only two primary breeds, the setting spaniel and the Spanish pointer. Actually some very fine breeds of dogs came along quite late.

For instance, the first record of the Weimaraner was in 1810, although he may have existed earlier. However, the wirehaired pointing griffon was not developed until 1874, and the German shepherd was just a dream in a breeder's mind until towards the close to the 19th century. It is true that breeders have made a neurotic mess out of the collie, but they were also responsible for gentling the once-ferocious great dane.

Nevertheless, for several decades now breeders, not only in the United States but also in Germany and some other countries as well, have been damaging one breed after another. There are two main reasons for this. The first one is the breeding methods used. The second one is economic. They tend to get mixed.

7 What breeding methods produced your pup?

There are three basic methods of dog breeding:

In-breeding—the breeding of closely-related animals such as mother to son or brother to sister.

Line-breeding—the breeding of less closely related animals such as "cousins," "nephew to aunt" and the like.



The poodle still has the potential of being a great hunter, although he doesn't look it.

Cross-breeding—the breeding of unrelated animals within the same breed.

The closer the relationship the more likely that desirable traits will be fixed in the puppies. Also, of course, the more closely related the mating animals are to each other the more chance there is that defects in one or the other will crop up in the puppies. Breeders tend to use in-breeding for specific results, line-breeding to improve the line, and cross-breeding (or out-crossing, as they call it) to correct their breeding mistakes. Competent and reputable breeders will out-cross after a few generations of in-breeding or several generations of line-breeding.

8 Defects of temperament.

However, animal breeding is one of the most challenging occupations, often rewarding, but always risky. Many times the mistakes are not

crossed out. Too, many breeders are in business only to sell puppies. "Desirable" traits are readily visible in a puppy, but defects of temperament, for instance, are not. As there is a possibility when cross-breeding that desirable qualities as well as defects will be removed, there is a temptation for such breeders to out-cross less and less frequently, and sometimes not at all.

9 Popularity can be harmful.

It is becoming a truism in the field that popularity (as always, with some exceptions) is injurious to a breed. One notorious example is the German shepherd. In the 1920s, when the Rin-Tin-Tin craze was at its height, the German shepherd became so popular, that German breeders exported numerous defective dogs to the United States when normally these animals would have been either destroyed or neutered. German shepherds (or "police dogs" as most unknowing Americans called them) won a reputation for viciousness. This reputation was as undeserved as it was unenviable. Normally, the German shepherd while an aloof dog is also a gentle one.

10 Avoid miniaturization.

Miniaturization has taken its toll of as many dogs as popularity. While the French or standard poodle seems to be one of the few breeds not seriously hurt by breeders, he has been reduced in size twice, first to a miniature, and then to a toy. Toy poodles are little more than yipping bits of fluff. And so it has gone with many other breeds. The reason is, of course, obvious in a nation of apartment dwellers. A toy is easier to keep in an apartment than a St. Bernard. ■

Computers can be fun



Computer chess tournament was held at a Computing Machinery festival. Rules were the same, but moves were exchanged by phone and transferred to boards.

ALMOST EVERYONE got involved with a computer at the Association for Computing Machinery's recent festival in New York City and the verdict was that the experience was fun. In one corner of a big room at the Hilton Hotel, a group of grade-schoolers, all boys, played chess with a computer. The board, complete with pieces, appeared on a screen. When a player wanted to jump a piece, he touched a light pen to it. A few of the youngsters beat the computer.

"This is a fairly good computer chess program, considering that it beat one of the other programs," noted its creator, Chris Daly of Goddard Space Flight Center, who was watching the action. "It's written for a Varian 620. Right now, it's easy to beat. How easy it is to beat depends on how fast it looks ahead—if it looks ahead further, it's harder to beat but the game takes longer."

Daly created a more complex chess program that he entered in the

festival's chess tournament, but it lost out to a program from Northwestern University. Six chess programs competed in the tournament, the first one of its kind. The rules of play were identical to those for regular human tournaments, although the moves were exchanged by telephone. Hundreds of chess buffs watched as the moves were transferred to posterlike boards.

For those less sophisticated in computer interaction, Donald E. Hall of MIT's Lincoln Lab drew computer pictures on a screen. "Try number 15-16," someone called out. Hall obligingly pressed some buttons and a tiny pattern of lines appeared that soon spread into a star. "There's a different picture for each pair of numbers," he explained. "This doesn't represent any very complicated program, but if people want to see pictures, I'll draw pictures. Basically, though, this is an information retrieval system."

Nearby, several youngsters from

Riverdale Country Day School, an elementary school in Riverdale, New York, were devising their own computer programs in a display set up by Call-A-Computer, a Minneapolis firm. "This boy is writing a program simulating a rat in a maze," explained spokesman Mike Lowrey, indicating a boy peering intently at a screen. "He wrote it here, today." "I think my problem is that I've got these two reversed," said the boy, pointing to the words "cheese" and "hunger."

Programs in the form of games that were devised by other youngsters

were already stored in computers at the Call-A-Computer exhibit. A woman visitor sat down at a keyboard to try one called Poluts, which was created by a 16-year-old named Jim Storer from Lexington, Massachusetts. In Jim's game, the player is dictator of an island kingdom with a pollution problem and a faltering economy. After 10 minutes the woman abdicated, her country's economy in ruins.

"I feel very old," she confessed, as she relinquished her seat to a grade-schooler eager to try Poluts.

Use caution with carbon tet

A hunter took his insulated, lightweight hunting suit to a do-it-yourself drycleaning establishment. On the way home, he became sick, dizzy and confused. A teen-ager crawled into a freshly-cleaned sleeping bag, zipped it up and went to sleep. He never woke up.

The culprit, in both cases, was carbon tetrachloride, or carbon "tet," a powerful cleaning agent used under as many as 35 trade names.

Brief exposure to even a tablespoon of carbon tet in a small, poorly ventilated room can produce acute poisoning or even death. Lower concentrations and repeated exposure can result in headaches, confusion, depression, nausea, vomiting, loss of coordination and visual disturbances. Some medical experts contend that the chemical has delayed side effects on the liver and other organs.

Not all carbon tet is in cleaners. Some fire extinguishers, particularly the kind used by campers and hunters, contain the chemical. So do some quick-drying lacquers, paint thinners, paint and varnish removers, metal

polishes, rubber cements, insecticides, dry hair shampoos, fumigants and other products.

Small children are in particular danger from carbon tet because the toxic fumes tend to hang near the floor.

What can you do to protect yourself from the effects of carbon tet poisoning? Select products carefully. Read warnings on containers. Use all cleaners and solvents in well-ventilated surroundings—if possible, outdoors. One expert says a well ventilated room is one with two or three doors or windows open and a breeze blowing.

—Reed G. Hildreth

Mud on the moon

The material dug up on the moon by the unmanned Soviet spaceship Luna 16 looks like "dry mud," according to an observer at the Academy of Science Laboratory in Moscow. American astronauts reported much the same first impression about moon soil. From the Soviet craft a robot arm holding an electric drill dug down 14 inches in the lunar soil to

retrieve the samples in the Sea of Fertility. After Luna 16 returned to Russia, the moon material was taken to the Academy. There it was sealed in a stainless steel chamber. Pumps sucked out the air and a sterilizing gas was let in, after which the chamber was filled with helium. Results of the analysis of the rocks will be published, the Soviets said.

New anti-smoking drugs

Some drugs really do block the impulse to smoke, work with four adult rhesus monkeys at the Albert Einstein College of Medicine indicates. The monkeys could puff either on a tube that gave them air or a tube attached to a cigarette to receive a water reward. Without drugs, the four primates all preferred to puff on the smoke tube.

When three drugs—mecamylamine, hexamethonium and pentobarbital—that are known to block the effects of nicotine were administered to the monkeys, they changed their preferences. They began to puff more on the air tube. Two monkeys who had been given mecamylamine retained their preference for the air tube even after the drug was discontinued. The aversion persisted for as long as the monkeys were observed—one month.

The researchers suggest in *Nature* that nicotine itself is the rewarding factor in cigarette smoke and that smoke by itself is unpleasant.

Case for small family

Is there any advantage to children and parents in a small family as opposed to a large family—four or more children?

The Population Reference Bureau,

Washington, D.C., which surveyed literature on the subject recently, reports that children from smaller families tend to be brighter, bigger, more vigorous and more responsive than the progeny of larger families. Small family children seem to have better relations with both their parents and their brothers and sisters, too. In most of the studies, social class was separated from family size for investigative purposes.

As for parents, mothers and fathers of larger families—particularly mothers—are more prone to ill health, both physical and mental. In unhappy marriages, the chance for parental happiness apparently decreases as the number of children increases. Marital adjustment, in fact, seems to be correlated with family size: the more children, the less ad-

Statue of the electric light bulb stands outside Sprinze, West Germany, in memory of a local inventor, Heinrich Goebel. According to local citizenry, Herr Goebel invented the electric light bulb a full 25 years before Thomas Edison, who is given the credit.

BIPS



justment there seems to be.

Some studies find no significant difference between large and small families in adjustment, the bureau notes. In general, large families tend to be less planned, with less intensive "parenting" (a danger in smaller families), early acceptance of realities and more crises, as well as more organization, discipline, conformity and specialization among the children. Small families are likely to emphasize planning, rationalism and prudence.

Only 30 percent of the children from large families wholeheartedly endorse the large family for themselves, points out the bureau.

Ultrasonic fossil-cleaning

Ultrasonic cleaning units at the La Brea tar pits in Los Angeles are cleaning small fossils much more speedily and safely than traditional methods. One of the devices, which use high frequency waves to pry dirt loose, cleans a fossil in just three minutes.

Assembly-line fossil-cleaning has been made simple by the use of ultrasonic devices. The units can do in three minutes what it once took a person 2½ weeks, and they are far safer for the fossil's fragile condition.



Before the cleaners were used, freeing a single fossil from the Ice Age dirt that encrusted it was a tedious job that took a staff member about two and one-half weeks of work with a needle under a microscope. The rate of recovery of fossils with ultrasonic cleaning is about 90 percent compared to 25 percent for hand-cleaned fossils. Branson Instruments of Stamford, Connecticut, supplies the cleaners.

Now it's asbestos masks

A disposable, portable respirator that can be worn by workers applying asbestos insulation will soon be available commercially, forecasts the Insulation Industry Hygiene Research Program. A number of models are now being tested and worker acceptance of the respirator, which looks something like the familiar "gas mask," has been good. In one series of tests conducted with a device developed by the Minnesota Mining and Manufacturing Company, workers wearing the respirator reported favorably on breathing, weight, vision and comfort. Single-use respirators are a must because of maintenance difficulties on construction sites. Inhalation of asbestos by insulation workers sometimes causes lung disease.

MSG called 'safe'

Monosodium glutamate (MSG) is safe to add to food, the Food and Drug Administration has decided. In recent years, MSG has been under fire. Authorities claimed that MSG was responsible for the Chinese Restaurant Syndrome (see *Science Digest*, May 1969, p. 40), a battery of uncomfortable symptoms experi-

enced by some persons after eating Chinese food. Other authorities claimed it produced damage in newborn mice when injected under the skin. Further experiments conducted by the National Academy of Sciences and the National Research Council, however, indicate there is no risk to man from normal use of monosodium glutamate. The Chinese Restaurant Syndrome? Just a transient allergic reaction, says the NAS/NRC. But uncomfortable.

Pamper your sesamoids

Higher heels on women's shoes may mean a return engagement of the wandering sesamoid, *Radiology News Digest* warns. The sesamoids are small bones on the ball of the foot at the base of the big toe. They act as a kind of ball bearing, diminishing friction, modifying pressure and altering direction of muscle pull. Prolonged wearing of high heels, however, occasionally fractures the sesamoids. When that happens, the tiny fragments tend to wander off. On an X-ray, a fractured sesamoid tends to have an irregular line of division unlike the smooth oval or half-moon shapes of the normal sesamoids. How does a fractured sesamoid feel? Ouch. And they're hard to treat.

Best spots for White Christmas

Dreaming of a White Christmas? Your dream is likely to come true if you live in Alaska, in Caribou or Portland, Maine; in Escanaba, Marquette, or Sault Ste. Marie, Michigan; in Duluth or Minneapolis, Minnesota; in Concord, New Hampshire; in Rochester, Schenectady or Syracuse, New York; in Fargo or Devil's Lake,



Pictorial Parade

Hijack-detector in use at London's Heathrow Airport is this security doorway, which is able to detect any metal on a passenger as he passes through. An operator simply watches the buttons for a flash.

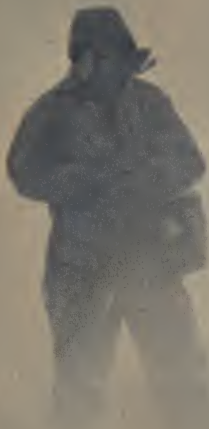
North Dakota; in Mansfield, Ohio; in Meacham, Oregon; or in Burlington, Vermont.

In all of these cities and a few others, reports the Environmental Science Services Administration (ESSA), snow has fallen on well over half of the past Christmases. By studying past weather records for U.S. cities, ESSA rates each one on its chances for snow on any particular Christmas. Marquette, Michigan, for example, gets an 83, which means that it has snowed over eight years out of ten in Marquette.

But the best place to be in the U.S. if you want a white Christmas is International Falls, Minnesota. It is the only city to which ESSA gives a 100 rating. ■

You feel colder because of the

WIND CHILL FACTOR





by Bob Kevern

THE TEMPERATURE outdoors is 47° F. You put on what you think is the proper weight clothing and step out into the cool air. Soon you begin to realize however, that it's chillier than you thought. In fact, it feels downright cold and you know that if you are going to spend any length of time outside you're going to need warmer clothing.

This sort of thing has happened to every outdoorsman and camper and it's all because of the wind. Even though the temperature may be 47°, add a 15-mph wind to that and the combined effect on the exposed flesh of the human body is the same as standing in no wind at a temperature of 32° F.

This combining of the air temperature (in this case 47°) and the wind speed (15 mph) equals out to what we call the "chill temperature." The United States Army was first to do research in this field. They found that though soldiers thought they were properly dressed for a given air temperature, many times they complained of being too cold. Scientists knew the wind produced the feeling of being colder, but it wasn't until they began experimenting that they found out just how much the simulated effect of temperature and wind had on the human body.

The chill comes from the wind which cools away our body heat. As wind rushes around a body, outer

Photos: Photo Trends

On the Barrier Ice of Antarctica, left, ambient temperature was -47° F. when this photo was taken. But winds gusting to 40 mph produced a chill factor sending it to an effective -128°. To withstand such cold these men wear heavily insulated suits.

"When the chill temperature reaches -25° . . . danger to your survival increases greatly."

clothing is cooled. Eventually, this coolness penetrates from the outside to the inside next to a person's skin where perspiration on the skin is chilled. The lower the temperature and the faster the wind, the quicker this process occurs and the more uncomfortable we become.

Of course those parts of the body that are exposed to the wind without any protection, such as hands and face, lose heat immediately. It's much the same as an engine fan cooling a motor. The faster the fan rotates, the cooler your engine can become because of the air blowing over it. But any exposed area of the body subjected to the wind receives the full force of the chill effect, and frost bite can occur at what could be considered moderate temperatures.

More wind—more chill

This wind effect also holds true for persons riding snowmobiles or skiing. In either of these cases however, you add the wind speed to the speed you are traveling. Thus, if the wind is blowing 10 mph and you are moving into it at 20 mph, you would add the two speeds together which means you are encountering an actual air movement against your body of 30 mph. If the temperature is 12° F., the 30 mph air speed would give you a chill temperature of 29° below zero. The same as being outdoor when the temperature is -29° F. and there is no wind.

One winter camper I know was telling me about a cold day when the temperature was near zero. He found

it was difficult to dress warmly enough in order to stay outdoors for any length of time. On this particular day the winds were running about 30 mph and gusting up to 40 mph. Under these conditions he was exposed to a chill temperature of -47° to -53° . No wonder he had difficulty in keeping warm.

Check your equipment

Another friend of mine was making a winter trip into Northern Minnesota a few years back and encountered a weather situation where the temperature dropped to about 30 below and the winds whipped around his trailer at 35 mph. I'll never forget the look on his face when I told him those conditions were the same as being in a cold wave of 101° below zero with no wind.

When the chill temperature gets that cold, it's advisable to be extremely cautious, guarding against overexposure to the wind, making sure everything is working properly and protecting against breakdowns or the chance of becoming stranded.

Anytime the chill temperature becomes -25° or more, the danger to your survival increases greatly. So if you're a winter outdoorsman, keep your equipment in top condition. Remember, it's always colder than you think.

At right we've set up a chart to help you compute how cold it *really* is when the wind blows. Clip the chart and keep it in your wallet or purse this winter for handy reference when the weather gets rough. ■



Antarctic sled dogs avoid effects of polar wind chill by deliberately letting drift cover them. Tents are kept snug by piling snow all around the perimeter (right).



CHILL TEMPERATURE

OUTDOOR TEMPERATURE	WIND SPEED							
	5	10	15	20	25	30	35	40
47	45	37	32	28	26	24	23	22
42	39	31	25	21	19	16	15	14
37	34	25	18	14	12	9	7	6
32	29	19	12	7	4	1	0	-2
27	24	13	7	1	-3	-6	-8	-9
22	18	7	1	-6	-10	-14	-15	-17
17	13	0	-8	-13	-17	-21	-23	-25
12	8	-6	-14	-21	-25	-29	-31	-33
7	3	-12	-22	-28	-32	-36	-38	-41
2	-2	-18	-31	-35	-40	-43	-45	-49
0	-5	-21	-36	-39	-44	-47	-49	-53
-2	-7	-24	-38	-42	-47	-51	-53	-57
-7	-12	-30	-42	-49	-55	-59	-62	-65
-12	-17	-36	-48	-56	-62	-67	-70	-73
-17	-23	-42	-54	-63	-70	-75	-78	-81
-22	-28	-49	-61	-70	-77	-82	-86	-88
-27	-33	-55	-68	-78	-84	-90	-94	-96
-32	-38	-61	-75	-85	-92	-97	-101	-104
-37	-44	-67	-81	-92	-100	-105	-109	-112
-42	-49	-73	-88	-99	-107	-113	-117	-120
-47	-54	-79	-95	-106	-114	-121	-125	-128

How to use the wind chart: Find the wind speed at the bottom of the chart, or the number closest to the one you need. Moving up the column from the wind speed, stop on the figure that is directly across from the actual air temperature in the far left hand column. Example: The wind is blowing at 19 MPH, the outdoor temperature is 3 degrees. In the wind speed column 20 MPH is the closest figure to 19. Moving up the column you would stop directly across from the figure 2 because that is the closest number to 3. The chill temperature reading is -35° .



What noise does to plants

CAN NOISE DAMAGE or even kill plants? A Denver, Colorado, college student theorizes that loud noise—specifically rock music—may have a destructive effect not only on plants but also on human behavior.

For two years Mrs. Dorothy Retallack, a 48-year-old recent graduate of Temple Buell College, has experimented with potted plants. She found that the plants she exposed to loud

rock music withered and finally died. Those plants she exposed to soft, semi-classical music reacted favorably and even grew toward the sound.

Mrs. Retallack's experiments were supervised by her biology professor, Francis F. Broman, who saw to it that scientific methods were used. A mother of eight children, Mrs. Retallack began her experiments as a required project in a college biology



SIPS Photos

Mrs. Dorothy Retallack stands in front of the environmental chamber where her potted plants are flourishing on a diet of light, water, nutrients and Bach organ music. Other plants died when exposed to rock.

course she took when she was working on her bachelor degree along with several of her children. The middle-aged housewife-student, a music major, sent the biology department at Temple Buell into a mild tizzy when her observations were made public. She thinks there may be a link between loud rock and anti-social behavior among college students, and she plans to continue her experiments. ■

The withered stems and leaves of a bean plant at right in the top picture were produced when the plant was exposed to rock music. The healthy plant in same picture was exposed to light classical music.

The scrawny root system of the bean plant at right in the picture above belongs to a plant exposed to loud rock music. The healthy roots at left belong to a plant raised with quiet, bland music.

The junkie personality

by Arthur J. Snider

THE BRITISH SYSTEM of providing maintenance doses of drugs for addicts does not work because it does not suit the addict personality, says a British physician who has had experience with hundreds of junkies.

"A maintenance dose will no doubt keep him on a dull level without suffering, but life would always be drab and dreary," writes Dr. A. J. Hawes in the journal, *Lancet*. "So to infuse a little color into this barren existence he must have a little more and then a little more still. The addict has no inner resources to combat the ordinary stresses of life. He must have some help outside himself and the only help he knows is heroin."

Far from apologizing for his addiction, the junkie seems to think himself entitled to it, says Dr. Hawes. Since addiction is officially an illness in England, he has no qualms about accepting sick benefits or assistance under the National Health Service. This help is used chiefly to augment his drug supplies from black market.

"Another element in the addict's character, which his pitiful appearance makes less easy to detect, is his underlying aggression," says the physician. "It was no doubt directed at first against his earliest frustrating figures in childhood and then by identification against everybody else. Your time belongs to him and he demands it any time of the day or night. He breaks every promise he makes and repays months of trouble and care with deceit and trickery. If he agrees to cut down his drugs, he makes up for the shortage from the black mar-

ket. He makes no effort to please by the faintest attempt to cooperate. By his unkempt and bedraggled appearance, he is in fact saying to the doctor (the parent substitute), 'You treated me badly and I'll [punish you] by looking like this.'"

The addict is also a show-off. He courts attention. When cashing his



prescription at the drug store he always talks loudly to other addicts, as if proclaiming his addiction to the other customers. He dresses conspicuously and his behavior makes him recognizable at once to anyone who has seen an addict before.

In Dr. Hawes' experience, cure of the confirmed addict is gloomy. He knows of only one who has remained free after five years. He believes, therefore, that prevention is the only hope. The problem then resolves itself into discovering the addict personality before it is fixed and unchangeable. A broken home and an emotionally disturbed or deprived childhood are often believed to be the chief factors in the development of the future addict.

Children's political fears

What are kids afraid of? Forty years ago younger children feared noise and animals, supernatural events and supernatural beings. From age eight to adolescence, fears branched out to bodily injury, punishment and school.

Dr. James W. Croake of Florida State University decided to find out what are the fears in this middle third of the 20th-century. An interview sample was drawn among third- and sixth-grade students from 12 schools in two states.

These were the most frequently mentioned fears (not in order): Bugs and wild animals, ghosts, darkness, tornadoes, thunder and lightning, personal relations (meeting new kids), school tests and grades, home punishment, fear of something happening to mom and dad, getting hurt while playing, getting lost, hair style, weight and politics (Communists taking over, war).

The category receiving the highest percentage of "almost always worry about" is politics, a classification that never disturbed youngsters four decades ago. "The Vietnam war, television and generally improved mass communication may account for the importance of political fears at an early age," says Croake.

Uric acid = high intelligence?

If you are successful, there is a strong chance of an unusual amount of uric acid in your blood, Yale University researchers say. They have found in their own observations and in a review of the literature that high uric acid levels go along with achievement, motivation, grades and aptitude. (See "Gout," *Science Digest*, March 1970, page 76.)

Dr. S. V. Kasl and his associates at New Haven say that more work must be done to determine if uric acid itself is the cause of high achievement or if high achievement causes the level of uric acid in the blood to rise. They also suggest as worthy of exploration the thesis that some mentally retarded might benefit from having their uric acid levels raised artificially.

Uric acid is a normal chemical constituent of the blood but is present in abnormal amounts in persons with gout.

The healthy fat man

Fat? Forget it. Some people are born to be plump and should remain that way, says Prof. C. Wesley Dupertuis of the Case Western Reserve School of Medicine, Cleveland.

"We have been brainwashed into believing that we are better off if we reduce our weight to conform to some theoretical ideal which is quite unrealistic for the majority of people, he contends. "Some people are naturally fat, others muscular and still others are thin in varying degrees. But we all are expected to conform to some hypothetical norm when it comes to our body weight."

Dupertuis, an anthropologist, says body weight depends on several factors, including the size and heaviness of the bony framework, the amount and condition of muscle, the weight of internal organs and the inherited tendency toward producing and storing fat.

The scientist found in measuring the Cleveland Browns football team that many were 40 to 60 pounds above the ideal weight for their height and age, but they were not obese in view of their massive musculature,

heavy skeletons and enormous chests. "It would be impossible to reduce these men down to fit the standard insurance tables without making them sick," he declared.

Reducing makes many people nervous, tense and irritable, Dupertuis points out. "Some get gastrointestinal upsets. Many find their resistance is lowered."

People who are fat have important contributions to make, he emphasized. "They are warm, have empathy, love people and often have great tolerance and compassion. If they try to keep their weight down, they become miserable and neurotic."

Attacks of anxiety

People who can't blow off steam, who pride themselves on maintaining an even temper, who never object when people impose on them, are candidates for attacks of anxiety.

Anxiety is a fear that suddenly arises over the state of one's health or mental stability. It may be seen as a minor nervous twitch or a near-panic marked by fast heart beat, dizziness, dry mouth, perspiration and an urge to escape.

Dr. Jackson A. Smith, chief of psychiatry at Loyola University school of medicine, sees it in many patients—the older sister on whom the rest of the family unloads the responsibility and expense of caring for elderly parents, the good friend who never refuses a committee appointment, the alcoholic's wife who gradually takes on his responsibilities.

"Get mad," is Dr. Smith's frequent advice. "Express your anger."

He also finds anxiety in the patient, age 40 or over, who suddenly wants an examination after years of avoiding

doctors. Careful questioning brings out the fact that a friend or fellow employe in the same age group, following the same pattern of living, and apparently in good health, suddenly died of a heart attack.

He usually chooses some indefinite symptoms as the reason for his office visit. He won't say, "I want a checkup



because I'm scared to death of dying." Instead, he'll say, "I'm feeling run down" or "I just decided to have a checkup." Or he may complain of insomnia, indigestion, fatigue or back pain.

Anxiety is also seen in changes that threaten a patient's security. "Since a man's work is a major factor in his security, a job problem is often the source of anxiety, Dr. Smith points out in *American Family Practice*. "For example, the promotion of a younger man over an older one is undeniable proof to him of aging and of a decreasing capacity to compete successfully. In our society this is no small threat."

It also can occur when a person is promoted to a supervisory position for which he is poorly suited by training or desire.

A woman in her late 40s who

dressess, acts and talks as if she were in her 20s usually is anxious because of aging. A 16-year-old girl whose appearance and behavior are more suitable to middle age sometimes has an anxiety problem, too.

"Ordinarily the patient is much less concerned about what caused his anxiety than he is with making certain that it is not the beginning of a chronic mental illness or some rare affliction," Dr. Smith advises. "He finds it comforting to be told that anxiety is actually a common but often concealed problem."

Dizzy deep-breathers

Get dizzy frequently? You may be breathing too deeply. A physician reported to the American Medical Association that dizziness is a symptom in 85 percent of "hyperventilators."

Hyperventilation, or overbreathing, washes out of the system too much carbon dioxide and takes in too much oxygen, according to Dr. Thomas P. Lowry of the University of New Mexico. This increases the oxygen saturation of brain tissue, produces a slowing of brain wave activity and brings on the giddy, woozy, light-headed feeling.

Cancer attitudes count

Few doctors like to treat advanced cancer. Often the prognosis is bad, and they feel there is little to be done. Some have a built-in fear of cancer themselves.

Dr. Herman A. Schwartz of the University of California Medical School, San Francisco, calls this "cruel rejection." The patient feels abandoned. He may sink into a deep depression and his spirit may die be-

fore his physical functions degenerate seriously.

"New treatments do work," says Dr. Schwartz, a cancer specialist. "They deserve more credit than most people, including doctors, will give. Long remissions often result from enthusiastic use of modern chemotherapy. Some improvement may last several years. Many patients live completely normal lives, hoping still better treatments may be discovered before the present ones lose their effect."

If a patient is given a positive and sympathetic explanation of his disease and what the doctor is going to do about it, he will join in fighting to arrest the malignancy. "Very few patients collapse when asked to deal realistically with cancer," Dr. Schwartz says. "Rather, many inspire us by drawing on unsuspected inner strength. I've seen many achieve a 100 percent remission in terms of participating in life. Many insisted on working until a few days before they died."

Pregnant? Gain 24 lbs.

The common practice of restricting a woman's weight gain to only 10 to 14 pounds during pregnancy may be harmful to the infant and contribute to the high mortality rate in this country. The National Research Council's committee on maternal nutrition believes the average weight gain should be about 24 pounds.

It is commonly believed that the fetus lives in a nirvana-like state in the womb and that nature protects it even if the mother does not receive adequate nourishment. But this is not true. Surveys of human experiences during World War II in lesser developed nations have shown that a

restricted diet may affect the growth and development of the fetus. Laboratory experiments on dogs and sheep show a marked reduction in the size of the offspring when the mother is maintained on an inadequate diet. Weight reductions are particularly harmful to underweight women, who make up as much as one-third of the prenatal patients.

The National Research Council also found that birth weight is affected by cigarette smoking. The more cigarettes women smoke, the lower the birth weight of their babies.

Girls who become pregnant before they are 17 years old run greater risks for themselves and their babies, the report said. Because they are growing, most girls under 17 have greater nutritional requirements in relation to body size than do adult women. Because of the trend in the U.S. toward marriage at an earlier age, the number of infants born to adolescents is on the rise.

Students' mental health

It would be a mistake to assume that the dissent on college campuses means a decline in mental health of students. On the contrary, Dr. Dana L. Farnsworth, Harvard University psychiatrist, believes their dissatisfaction connotes a higher-than-usual level of mental health, particularly in the realm of concern for others.

There is, however, a small percentage that expresses their indignation in the form of violence. They argue that violence is necessary in order to bring about needed reforms. Some of these students, particularly those who carry alienation to the point of withdrawing from the usual pursuits of current society, may well have profound emo-

tional disorders, says Dr. Farnsworth.

The psychiatrist finds little change in the percentage of persons dropping out of college since the first studies were begun 40 years ago. In general, of all students who enter college, about 40 percent will be graduated from their own institutions, another 20 percent will drop out, re-enroll elsewhere and finish their studies, and 40 percent will drop out not to resume their studies.

Small victory against leukemia

The encouraging finding that emerged from a survey of 11 leading medical centers is that the most prevalent type of leukemia in children is yielding, however slowly. The median survival time, measured over a seven-year period, has increased from nine to 13 months. Ten percent of the 1,770 children studied have survived 20 to 27 months. There were 26 who survived four years, and 15 who survived five years or more. There are at least 12 children who have lived up to nine years after diagnosis. Before the period of current drug therapy, survival was 55 to 100 days.

The five drugs that provided the best results in children with leukemia during the 1960s are the following:

Cytosan—Recommended primarily for early relapses.

Vincristine—The best drug for initial treatment because it produces the highest percentage of remissions in the shortest period. However, it has disagreeable side effects.

Cytosine arabinoside—Useful when leukemia has become resistant to other drugs.

Dactinomycin—An antibiotic developed in Italy and showing promise in

early experiments in this country.

L-asparaginase—An enzyme that has brought about complete elimination of symptoms in a very small number of patients. Supply of the compound is limited.

Wacky biological clocks

Travel by jet has demonstrated that people are creatures of rhythm. Man adapts to a repetitive daily timetable based on a day-night cycle and suffers fatigue and discomfort when jolted out of it.

Most long-distance plane passengers find their enthusiasm for work or play is reduced when the local wall



Drawings by Ellen Williams

clock is out of phase with their body clock. Diplomats are instructed to make no important decisions for several days after reaching a distant destination, and many business men will transact no affairs for at least 24 hours after arriving because of the "jet syndrome."

Passengers speed through several time zones in flying 7½ hours from Chicago to London, 23 hours from Chicago to Sydney, Australia, nine hours from Moscow to New York and 14 hours from San Francisco to Paris. The proposed supersonic transport with a longer range and greater speed, will aggravate the problem, in the opinion of airline pilots.

"This is a very sensitive issue with us right now," comments Capt. Clifford Eugene Huggins, a Braniff pilot and chairman of the aeromedical study group of the International Federation of Aeronautical Pilots. "The carriers and the federal government recognize time-zone fatigue in passengers, but not in pilots. The present federal regulations on maximum flying time for pilots were drawn when airplanes flew 165 miles an hour, not 620. There is not a single contract that recognizes the concept of time-zone fatigue."

Statistics show that accidents occurring in international operations are 45 percent higher than domestic operations. Time zone fatigue, Huggins says, causes a pilot to lose sharpness and reaction time.

On the other hand, Dr. George J. Kidera, medical director of United Air Lines, believes the SST will tend to improve rather than aggravate the jet syndrome. "It will mean the pilot will be able to leave his home in the morning, turn around and be back home the same day," said Kidera.

Sweetened cereal and tooth decay

Cereal manufacturers, already under fire from nutritionists, aren't pleasing the dentists either. Pre-sweetened cereals are more harmful to teeth than plain cereals sweetened from the sugar bowl. Dentists report that sugar firmly attached to the cereals is more readily impacted in the fissures of the grinding surfaces, similar to chewy candy. Dr. Philip White, director of the nutrition department of the American Medical Association, says it is likely that pre-sweetened cereal contains about 20 percent more sugar than cereals sweetened by children. ■



**Ultrasonic sewing machine
does away with stitching**

Instead of conventional stitching together of seams, clothing can now be welded together with an electronic device which joins the seams by ultrasonic vibrations. Welding occurs when the vibrations cause one piece of fabric to vibrate against the other, creating a molecular change which joins or "sews" the pieces together. This technique can also be used in the manufacture of films, blankets, bandages, filters and sailcloth and other synthetic materials. Branson Sonic Power Co., Danbury, Conn.



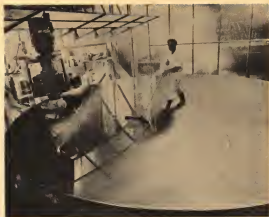
**Giant steel tunnel section
launched in Mobile, Alabama**

Seven of these huge structures will be joined together beneath the Mobile River to enclose a four-lane highway. Built by Alabama Dry Dock and Ship Building, Mobile.



**First continuous dye laser
may be useful to communications**

This new laser offers low cost advantages over other lasing materials such as rubies, glasses and gases. Eastman Kodak Co., Rochester, New York.

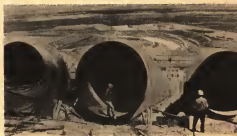


Liquid membrane offers new separation techniques

A new approach to liquid separation may have great potential in petroleum refining, water treatment and other fields. Liquid membrane is composed of solution of surfactant, certain additives and a solvent. Droplets of a mixture are separated when they pass through solution which forms a thin film around them. Developed at Esso Research, Linden, N.J.

World's largest artificial sun almost completed

This technician is washing the new 23-foot diameter collimating mirror which will act as a solar simulator in deep-space testing research in labs at Martin Marietta, prime NASA contractor for the Viking Project. Mirror will simulate sun by reflecting light from a bank of 19 xenon short arc lamps. Spectrolab, Sylmar, Calif.



Aqueduct to lift millions of gallons over mountains

Four steel pipes especially treated with anti-corrosion coatings will carry up to two million gallons of water per minute over California's Tehachapi Mountain foot hills. Water will be pumped from Wind Gap, Calif. Koppers Co., Los Angeles.



Desert lizard, Dipsosaurus, is being studied by Dr. Warren Porter, University of Wisconsin zoologist, in a special desert room at the school's new Biotron.

World's climate in one lab

ONE OF THE FEW PLACES in the world where you can stroll through an Arctic wind; a Nigerian growing season and an American desert, all within a few steps, is on the campus of the *University of Wisconsin* at Madison.

This past fall, the university dedicated its new "Biotron," the biggest, most varied and most expensive (five million dollars, part donated by the National Science Foundation) of the new climate-controlled laboratories now being erected around the country. The idea behind climate

simulation is to speed up research on the effects of environment on plants and animals. The Biotron already has many of its 48 chambers in use.

A dry, warm room about the size of a large bathroom has the same climate as a desert near Palm Springs, California. Here a number of lizards are being studied by Dr. Warren Porter, a zoologist, who is trying to predict their body temperature at any particular time of day by checking environmental changes. Already, he has been able to forecast the temperatures within a single degree. Such in-

ternal changes dictate the lizards' activities.

In a more humid chamber that simulates the climate of southern Nigeria, Dr. Fred A. Bliss is investigating the effects of the local weather on black-eyed peas in order to increase their production of protein. Protein is in short supply in the Nigerian diet. A frigid, windy chamber nearby that feels uncomfortably like an Arctic winter is serving as a testing ground for a new wind gauge created by the Space Science and Engineering Department. Eventually, the gauge will aid cloud-seeding efforts.

One room simulates the non-exotic climate of Madison, Wisconsin, where the university is located. Robert K. Ham, a civil engineer, is studying the decomposition of both loose and shredded garbage in an attempt to understand different types of degradation, including the gases

produced in the process. The study is part of Madison's Refuse Reduction Project, an effort to develop better methods of waste disposal.

Scientists from other institutions frequently make use of the Biotron's facilities, too. At the moment, a Beloit (Wisconsin) biologist, Mrs. Elizabeth Souter, is raising potato plants in two chambers to find out how temperature affects pollen development, and researchers from Ralston Purina are testing various hen feeds. A Finnish biologist just completed a study of the crown gall, a common plant tumor.

A computer controls the weather in all 48 chambers, holding climactic factors constant or varying them at intervals. To keep out fungi and bacteria, visitors are required to shower and change clothes and animals are washed or carried to their chambers in sealed containers. Equipment is sterilized when practicable.

Learning to be hypnotized

In a dimly-lit room in the *University of California at Irvine*, a young man sits in a padded arm chair, apparently asleep. A strobe light flashes in front of the chair. In an adjoining room, Dr. Joe Hart, a psychologist, monitors a polygraph, an instrument that records and measures brain waves. Wires on the subject's head lead to the polygraph.

"There is an abundance of slow brain waves," comments Dr. Hart, reading the polygraph record. "During these periods of slow patterns, the strobe flashes in front of the subject's chair, signaling him that he is producing the desired pattern. By being made aware of these periods, he is able to repeat them by putting his

mind in a similar state." The technique is called the "feedback loop."

Using this technique, Dr. Hart says, he can make a person more susceptible to hypnosis by changing the frequency of his brain waves. Earlier, it had been discovered that persons with an abundance of slow patterns were more susceptible to hypnosis. After about five 30-minute sessions in which the strobe indicates slow waves, the subject can produce slow waves whenever he wants to.

There is some evidence that long periods of intense concentration are associated with fast waves, while deep emotions on hearing music are related to slow waves. Extrasensory perception (ESP), like hypnosis, seems to be correlated with slow

waves. All these abilities, Dr. Hart thinks, may eventually be taught by the feedback loop. He is working on programs to facilitate the learning of both slow-oriented and fast-oriented skills.

—Patrick Boyle

Whistling long distance

A blind *University of South Florida* student who can imitate the sounds of long-distance dialing equipment placed calls free until the phone company caught up with him. After he was reprimanded by the university, the psychology department began investigating how Joe Engressia does it. On the surface, it's simple: he whistles a sequence of tones into the phone to which the long-distance relays re-

act. Studies in the psychology lab indicate Joe has a memory for the frequency of sounds far better than that of musicians. But the lab still doesn't know how he remembers the frequencies, much less their sequence. Psychologist Dr. Harold L. Hawkins thinks it may involve "symbolic encoding" similar to the way in which we remember words and put them together in speech.

Noise pollution cicada style

Those blasted cicadas! Can't I get any quiet? Probably not if you lived in an area where newly-emerged 17-year-cicadas were calling last summer, a report by *Princeton University* indicates. The loudness of several species of cicadas all calling at once is such that it may cause permanent injury to the eardrums of some mammals. Birds, the natural predators of cicadas, are driven away from the insects' mating areas by the noise. It doesn't bother the cicadas much, however, because they have a built-in protective device in their eardrums that automatically collapses it before the onset of sound. Measuring the noise 60 feet away from a tree in which thousands of cicadas were calling, Dr. James A. Simmons found it was between 80 and 100 decibels.

This goat has been made neurotic by scientists at Cornell University in Ithaca, N.Y., to see exactly what causes neurotic behavior. The results will hopefully be applicable to human neurosis. Tubing around abdomen reads respiration and heart rate.

Three Lions



Non-sensory communication

Brain-to-brain communication without going through the senses has been demonstrated in a chimpanzee by *Yale University* neurophysiologist Dr. Jose M.R. Delgado. The ingenious experiment involved electrodes, a receiver-transmitter and a computer. Brain waves were picked up by the



Electrodes implanted in this chimpanzee's brain picked up electrical brain waves which were then transmitted to a computer by the receiver-transmitter atop the animal's head. The first "non-sensory" communication was part of an experiment at Yale University.

electrodes, which were implanted in the animal's brain, and relayed to the computer by the transmitter. The computer returned a control signal to another part of the brain through the receiver. When the signal arrived, the second part of the brain turned off the activity of the first part. "I call it non-sensory communication," said Dr. Delgado, who plans to use the technique on humans within a year. Treatment of epileptics is one possibility.

Buffalo ate all the grass

The buffalo may have played an important role in the extinction of other large mammals on the North American continent some 10,000 years ago, says a *University of Iowa* geologist. According to Holmes Senken, the vast herds of buffalo, or bison, that migrated across the Bering Strait ate all

the available grasses on which most of the other large extinct animals depended. He discounts man the hunter's role in the extinctions because of the scarcity of artifacts found near animal skeletons. "If the animals were indeed killed by hunters, we would expect to find arrowheads and other man-made objects near most skeletons," he notes. Among the large mammals that once roamed our continent were mammoths, camels, six-foot beavers and giant sloths.

Six-foot dog found

The skull of a giant dog discovered on a Colorado ranch may strengthen the case for a land bridge between Europe and North America millions of years ago.

Dr. Peter Robinson of the *University of Colorado* was directing field work at the ranch on Piney Creek near State Bridge several years ago when a student, Peter Derven, unearthed the skull. The lower jaw of the skull could measure 14 inches. The lower jaw of a modern wolf, in contrast, measures only about nine inches. Dr. Robinson thinks the entire animal was about six feet long, not including its tail.

The skull was turned over to Dr. G. E. Lewys of the U.S. Geological Survey in Denver, who has positively identified it as a member of the species *Amphicyon major*, the original of which was found 100 years ago in France. Both specimens date from the Miocene epoch 12 to 15 million years ago.

The existence of the same species of dog in Colorado and in France is another indication that a land bridge once linked North America with Europe, Prof. Robinson believes. ■

How much do you know about the physics of sound?

by John and Molly Daugherty

SOUND REQUIRES A MEDIUM TO CONVEY SOUND WAVES from the source to your ear. You have two ears to help you locate the direction from which a sound comes. The low notes of an organ may seem to come from all around you; you can easily locate the high-pitched cry of a child. The creak of a cricket, however, produces countless reflections. What do you know about sound?

1. Sound waves are longitudinal waves. In air a vibrating tuning fork compresses adjacent air molecules in one direction and when rarefied, in the reverse direction. The *spring* of the air propagates these alternations of compression and rarefactions through the air parallel to the wave direction. Only the energy of waves—not the particles of air—is transmitted.

The velocity of sound varies with the nature of the material transmitting it. In which of these is the velocity of sound the greatest?



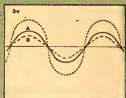
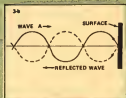
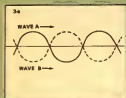
2. The energy of a sound wave generated by a vibrating source decreases as it travels outward, varying inversely with the square of the distance. The waves go out in all directions, and the wave fronts are concentric circles. The greater the amplitude, the greater the loudness—but pitch is also a factor. A high-pitched whistle of a referee can be heard more readily than a low-pitched one. The frequency of vibration (often referred to as *pitch*) and wave length remain constant. In some cases, however, the pitch apparently changes for the listener.

In which of these cases will the *apparent* pitch of the whistle be the highest to the man?



3. A wavy line known as a sine curve with crests and troughs can represent sound waves. A wave length is the distance from any given point to the next point where the wave motion starts to repeat itself. Amplitude is the distance from an axis line to the maximum displacement of a crest or trough. Frequency is the number of waves passing a given point in a second. Interference between two waves may be destructive, partially destructive or constructive.

Which one of these shows complete destructive interference?



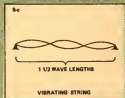
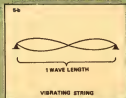
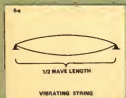
4. Musical instruments do not cover the same band of frequencies or encompass the same number of octaves.

Which ones of these instruments spans the least number of octaves?



5. Even though various musical instruments tune up to the pitch of the same note, you can usually tell the difference. The quality or timbre of the sound differs. This difference is caused by the presence of other harmonics in addition to the fundamental harmonic. The extra harmonics are overtones which are in succession an octave higher. The overtones vary not only in number but in intensity. A string can vibrate as a whole to produce the fundamental and at the same time vibrate in other segments to give overtones which blend with it and give the resultant quality or timbre.

Which of these illustrates the first overtone of the vibrating string?



Drawings by Merle B. Seals

(For answers, turn to page 92.)

ISAAC ASIMOV EXPLAINS

Each month Dr. Asimov chooses questions you send in to answer. He does not make his job easy, for he covers theoretical physics to biochemistry and he has written on topics from anti-gravity to biological clocks to what happens when an irresistible force meets an immovable object. Following Dr. Asimov's answer are the answers to some of your questions written by regular members of the *Science Digest* staff.



Why we must grow old

What is the purpose of aging?

It seems a shame to have to grow old and die, but it is apparently unavoidable. Organisms like ourselves are actually designed to grow old and die, for our cells seem to be "programmed" by their genes gradually to undergo those changes with time which we call aging.

Can aging have a use? Can it be beneficial?

Well, the most striking property of life, beyond its mere existence, is its versatility. There are living things on land, in the sea and in the air; in hot springs, in salt brines, in deserts, in jungles, in the polar wastes; everywhere. It is even possible to design environments like those we think exist on Mars or Jupiter and find simple forms of life that can manage to survive those conditions.

In order to achieve such versatility, there must be constant changes in gene combinations and in the nature of the genes themselves.

One-celled organisms divide, and each of the two daughter cells has the same genes the original cell had. If the genes were passed on as perfect copies from division to division forever, the nature of the original cell would never change no matter how often it divided and re-divided. However, the copy isn't always perfect; there are random changes ("mutations") every once in a while and gradually, from one parent cell, different strains, varieties, and, eventually, species arise ("evolution"). Some of these species are more successful in a particular environment than others are and in this way different species fill different environmental niches over the earth.

Sometimes individual one-celled organisms swap portions of chromosomes with each other. This primitive version of sex results in changes of gene combinations, which further hastens evolutionary change. In multicellular animals, sexual reproduction, involving the cooperation of two or-

ganisms, grew more and more important. The constant production of young with their genes a random mixture of some from one parent and some from the other, introduced variety beyond that possible by mutation alone. As a result, the pace of evolution was greatly hastened and species could more easily and readily spread out into new environmental niches or adapt themselves more closely to an old one so as to exploit it more efficiently than before.

The key to this, then, was the production of the young, with their new gene-combinations. Some of the new combinations might be very poor but these wouldn't last long. It would be the strikingly useful new combinations that would "make it" and crowd out the competition. In order for this to work best, however, the older generation with its "unimproved" gene combinations must not remain on the scene. To be sure, the oldsters would be bound to die off with time, thanks to accidents and the general attrition

of life, but it would be more efficient to help the process along.

Those species in which the earlier generations possessed cells that were designed to age, would be more efficient in getting rid of the old fogies and leaving the ground clear for youth. They would evolve faster and be more successful. We can see the disadvantage of longevity about us. The sequoia trees and the bristlecone pines that live for thousands of years are nearly extinct. The long-lived elephant isn't nearly as successful as the short-lived rat; or the long-lived tortoise as the short-lived lizard.

For the good of the species (even the human species) it seems best for the old to die that the young might live.

Sorry!

—Isaac Asimov

Please address all questions to Isaac Asimov Explains, *Science Digest Magazine*, 224 W. 57th, New York, N. Y. 10019.



"I've got 40 of the diseases in this 'Home Medical Adviser' you bought."

Shoot powdered ink for color printing

SAMUEL B. MCFARLANE JR. expects his new electrostatic printer to enable business houses to make inexpensive copies of sales promotion materials in color and at high speed. The machine transfers images by shooting powdered inks through the air onto plain paper, without touching it or applying any pressure.

McFarlane, president of Electro-Print, Inc., Palo Alto, Calif., was recently granted Patent 3,532,422. The company is developing the color

machine along with a black and white electrostatic printer on which he holds earlier patents and which has been built in prototype.

One color is transferred at a time. For office copying, the preferred order is black, blue, red and yellow. The image is reflected from the original onto a charged screen that is dusted with the proper ink. Through an electrostatic field, inks in the successive colors are projected onto the printing surface, which may be smooth, rough or corrugated paper, cardboard or cloth. The fixing is done with heat.

The McFarlane machine, so far as its inventor knows, is the only electrostatic color printer, and the only color printer of any kind that works with plain paper. Reproduction is described as of extremely fine quality.

The color process has been operated on a breadboard model in the laboratory of Stanford Research Institute, which is working with ElectroPrint under contract. The machine, which may reach the market in a year and a half, is designed for automatic and continuous operation.

A principal stockholder in Electro-Print is Sun Chemical Corporation, New York, of which McFarlane was formerly vice-president and director of research and development. Savin Business Machines Corporation, New York, has been licensed by Electro-Print to produce both the color and black and white printers, and has arranged with an affiliate in Japan to build a prototype of the latter machine there.

—Stacy V. Jones

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Claude Bernard, wearing apron, experiments on a rabbit before a group of colleagues.

CLAUDE BERNARD

father of experimental medicine

Bucking the hostility of bigots and a bitter wife who tried to destroy his work, this gentle physiologist dedicated his life to the betterment of human health.

by Richard Dunlop

EMILE ZOLA called Claude Bernard not just a physiologist but physiology itself, but to Bernard's wife Marie he was a bloody-handed fiend who cut up hapless dogs and cats.

It was Paris in the middle of the 19th century, and antivivisectionists were as furiously arrayed against medical scientists who experimented

on animals as they are today. The quarrel between Claude and Marie Bernard was talked about all over the city. Bernard, acknowledged the greatest of the physiologists, found himself under scathing attack in his own home.

Marie was tight-fisted and precise with money. She once scrupulously paid her daughter 25 centimes for a bite out of a three-franc candy Easter egg. This did not keep her from handing huge sums to antivivisectionist societies that attacked her husband. She attended their meetings and spoke up against his work. Emile Zola was so struck by the conflict between the scientist and his wife that he said he was tempted to model the scientist hero of his novel *Docteur Pascal* on "Claude Bernard, a scientist married to a bigoted woman, who

would destroy the results of his labors as he works."

Claude Bernard worked in spite of his wife. Other researchers were content to nibble at the fringes of the mystery of life, but Bernard set about exploring the nature of life itself.

This solitary hunter for scientific truth related ideas to the reality of experimentation as never before. The liver, theory said, destroyed sugar, and Bernard determined to prove the theory in his laboratory. He fed a dog a diet rich in sugar and then killed it while it was still digesting the food. He tested the blood in the hepatic veins leading from the liver, and to his surprise found that sugar dextrose was in rich supply.

"But how do I know that the sugar which I thus find in the hepatic vein is the same sugar as that which I introduced into the portal blood through the food?" he asked himself.

Secret of diabetes

He fed another dog on sheep's head only, making sure that no dextrose was present in the alimentary canal or the blood leading into the liver. Once again he killed the dog and examined the hepatic veins. The blood coming from the liver was as rich with dextrose as in the first dog.

He noted: "If the result which I have just got is confirmed on repetition of the experiment, the liver is a sugar-producing tissue. It manufactures sugar out of something which is not sugar, and within it lies the secret of diabetes."

He soon established that the hepatic sugar fluctuated in quantity depending upon diet and that long starvation brought about the end of production. Fatty foods did not in-

crease the liver's output, but gelatine or carbohydrates increased it markedly.

To Claude Bernard, the human body was a harmonious machine providing heat and energy within itself to carry on life. As early as 1844, he had put a thermometer through the jugular veins into the heart of a living horse to see whether blood leaving the lungs was cooler than that entering. It was. This showed that animal heat did not come from the lungs, as most doctors then believed, but from combustion within the tissues. With a colleague, he discovered a method of testing urine for sugar which is used in the diagnosis of diabetes to this day. He also studied the effects of the juice from the pancreas on digestion, work which was to bring him election to the Legion of Honor.

Bernard's work in his laboratory went on at all hours, which made his wife even more vindictive.

"Your father does not love you," she told their two daughters. "He thinks only of torturing poor helpless animals."

In time, the daughters came to look upon their father as a monster and trembled at the sight of the tall man with a tall hat perched on his graying locks as he came down the street toward their door. Both of the Bernards' sons died in infancy, and Bernard was alone in his family. One day Marie laughed with delight.

"The neighbors are saying that you are performing experiments on stray children you pick up in the streets," she said.

Bernard was shocked by the gossip, which soon turned most of the neighborhood against him. He was forced to move his laboratory to escape his hostile neighbors, but he could not

Bernard's daughters looked upon him as a monster who tortured innocent animals.

escape his hostile wife.

All his life Claude Bernard carried on a dialogue between the theories advanced by his active brain and the experimental fact provided by his laboratory. To him scientific theory was an intellectual tool for penetrating the mask of nature, but only laboratory fact had truth.

These qualities of mind were as evident in the boy as in the man. The man who to this day is honored as the father of experimental medicine began life on July 12, 1813, in a tiny farmhouse at St. Julien, a village among the vineyards of the Beaujolais.

Making of a scientist

The boy awoke every morning to a land of ancient villages and roads, to hills exposed to the rising sun which explained why the vineyards around him produced some of the finest wines of France. The houses of the village were walled with the yellow stone of the region and roofed with bulging tiles originally shaped on the muscular thighs of Roman workmen.

Through the gate at one end of the courtyard of the farmhouse young Claude helped carry the yearly vintage. He saw the new wine go out the opposite gate. It was this courtyard with its shady trees, its cooing pigeons and well, from which buckets drew cool drafts of water, that proved to be the first laboratory for the inquiring mind within the small boy. The village priest taught him Latin at age eight, and by the time he was 11 he was singing in the church choir.

This was a boy who laughed little, who dreamed much and stayed out of games. Other boys thought him unfriendly and not very bright.

When he went five miles away to school at the Convent of the Visitation in Villefranche, Claude studied Latin, Greek, French literature, arithmetic, and geography. The boy counted reading a waste of time. His teachers at the convent, angry because he would not read his lessons, disliked the child who returned their most furious glares with an insolent stare, his thin shoulders straight and unyielding. They were confronted with a boy, who later in life would write, "I never form an opinion from those of other people."

Claude Bernard grew tall and strong from working in the fields, with a fine head and searching eyes which became luminous and compassionate for anything that suffered. For a year he attended the College of Thoissey, but at 18 there was no more money for an education.

He was apprenticed to Louis Joseph Marie Millet, a pharmacist on the main street of Voise, a suburb of Lyons. He swept the pavement in front of the shop, rinsed bottles, ran errands and sometimes prepared pills and powders. He hated his life "bounded by four walls and 300 bottles." One day the pharmacist had him sweep up all the drugs spilled on the counter and floor while being

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The Bettmann Archive

Claude Bernard sat for this photograph in 1868—ten years before his death on February 10, 1878.

packaged in little squares of paper.

"Keep that for syrup," he told his apprentice. "That will do for making the syrup."

The pharmacist mixed the powder with honey and wine as a panacea for all aches and pains, while his apprentice looked on with disgust.

One night a month Claude was permitted an evening out, and he always went to the theater. Drama, musical comedy and vaudeville released him from four walls and 300 bottles. One night his fellow apprentice, Benoit Blanc, was surprised to find Claude at work writing a play. Claude read him what he had written, and Benoit was fascinated. When *La Rose du Rhone* was finished, Claude offered it to a Lyons theater. Both youths were delighted when it was bought for 100

francs and produced with success.

Quitting the pharmacy, Claude set to work on a second play about Arthur of Brittany. Light-hearted with this success, he returned to his village, where he now lived a companionable life. Dancing, sipping wine with his friends, playing cards, hunting, fishing, taking long walks through vine-clad hills, he thawed the loneliness of his spirit.

He was 21 when in November 1834, he set out in the stagecoach for Paris, ready to show his new play to Saint-Marc Girardin, famed critic and professor of French poetry at the Sorbonne. Girardin recognized in Bernard's "Arthur de Bretagne" writing of uncommon literary power, but looking at the poor youth standing before him and knowing how hard the world of the theater was, he said, "You have studied pharmacy; study medicine. You will much more surely gain a livelihood."

He urged Bernard to earn his bread by medicine and to use his leisure to write. In a few weeks Bernard enrolled in medical school and began the life of an impecunious student in the Latin Quarter. He taught natural history in a girls' school to help pay his fees and lived in a garret, where he cooked his meals in utensils borrowed from the medical laboratories.

It was in the anatomy classes that he first proved himself. His skill in dissection brought him to the attention of François Magendie, whose celebrated lectures he attended at the College of France. Bernard was not an attentive student, and in 1839 he passed his examinations fourth from the bottom of a list of 29 candidates. Despite his poor showing, Magendie, noting his talent for dissection, offered him the job of preparing

anatomical demonstrations for his lectures. Claude Bernard had fulfilled the requirements for a medical degree, but he never was to practice, for he was now in a laboratory, and in laboratories he was to spend most of his life.

Bernard described this first laboratory where he dissected for Magendie as "a sort of small closet where we two could scarcely fit ourselves." There he isolated the facial nerve of a rabbit with such precision that Magendie, the leading physiologist of France, remarked, "Well, you're a better man than I am." When Bernard was not working in the laboratory at the College of France, he was working in a crude private laboratory or in the chemistry laboratory of a friend.

In 1845, when he was 32 he married Marie Martin, daughter of a prominent Parisian physician. Their quarrel began soon after their wedding day and increased with the passing years until in 1869 Marie and their two daughters moved away, leaving Bernard to a sorrow which he could only forget in his familiar laboratory.

"Science absorbs and consumes me," he wrote to Mme. Hermann Raffalovich, wife of a Russian Jewish financier living in Paris, with whom he now struck up a platonic friendship. "I ask no more if it helps me to forget."

As early as March 1860, his health had broken down under the strain of his domestic life. He returned to St. Julien, where in 1861 he bought the manor house on a hill built by the Chevalier de Quincieux. He set up a laboratory in a shed back of the house, collected frogs in nearby swamps on afternoon walks, pruned

his roses, and grafted in his orchard.

His mind remained active at St. Julien. His swirling thoughts began to focus on the nature of physiological research until he wrote his *Introduction to the Study of Experimental Medicine*. Published in 1865, the book created a sensation in the world of science and medicine. The brilliance of his thought was matched by the beauty of the language, and Bernard was elected to the chair of physiology in the French Academy. There he joined other immortals of France, a man who was now as renowned for his writing as for his scientific research. Today his book still is considered one of the landmarks of the 19th century.

A friend in Napoleon

Napoleon III telegraphed him for news of his health as he lay sick during one of his attacks of fever and severe abdominal pain. Bernard himself walked to the telegraph station to send a reply. When he was better, he was summoned with his friend Louis Pasteur to the imperial court at Compiègne. The emperor and the two scientists talked together about the mysteries of life.

"You are a great man of science, and I want you to be pleased with me," said Napoleon to Bernard. He called his minister of public instruction to his side. "You know M. Claude Bernard; see that he has all that he wants."

Bernard told the minister, "For myself, I want nothing; but my science is in great want of laboratories."

As a result, a new laboratory was established at the Sorbonne and another at the Museum of Natural History to further medical research. Each

year found Bernard seeking further to fathom the mysteries of life.

In our day, internal combustion engines are the most dangerous source of carbon monoxide poisoning. In Bernard's day, leaky chimneys and closed flues were the principal sources of danger. Bernard set to work in his laboratory studying carbon monoxide. At the end of his experiments he concluded, "I was thus led to find that the gas rapidly poisons animals because it instantly displaces the oxygen of the red corpuscles and cannot be subsequently displaced by oxygen. The animal dies because the red corpuscles are, as it were, paralyzed and circulate as inert bodies devoid of the power of sustaining life."

A member of the French Senate

Elected a member of the French Senate, he supported Napoleon III, although when he requested 400,000 francs to endow his work at the Museum of Natural History, Napoleon turned him down with the remark, "Physiology costs as much as artillery." Not long afterward, Napoleon learned that his artillery was not of much service, for the Franco-Prussian War broke out and overthrew the empire he was building. As the Prussians encircled Paris, Claude Bernard left on the last train. Even as he spoke out in public meetings against the Prussian attack on France, he insisted that German-French friendship was indispensable to a European federation which must stand above all nationalities.

When the war was over, Claude Bernard returned to his laboratory and to lecturing at the College of France.

"The scientific medicine which it is

my duty to teach you does not exist," he told his students, who included Silas Weir Mitchell, later to become famous as the founder of neurology in America, and the Russian Sechenoff, who was in turn the teacher of Pavlov. Bernard used his lectures as a means of announcing new discoveries in his laboratory and correcting or extending his views.

Walking with George Barral on his way to a lecture at the College of France late in 1877, he was stopped at a street crossing by a passing funeral. Bernard pointed to the priest in the procession and said he hoped that he soon would have no such companion on his way to the grave. Since the death of his sons and the departure of his wife and daughters, Bernard often talked about death and Barral paid little heed. The lecture was his last. On New Year's Day he caught a "cold" which turned into an inflammation of the kidneys.

Doctors examined him. Bernard noted acidly when they had gone away that the senior doctor had washed his hands and instruments after the exam and the junior had done so before the exam. Bernard suffered pitifully.

"Nature is sometimes very stupid," he said. "Of what use is all this pain? It is useless for you or for me. I don't complain of suffering, I only complain that this suffering is of no use to anyone."

When it became evident that he was dying, scientists asked him about his work, hoping to glean one last shred of information for mankind. He roused himself but could only say, "It is all in my head, but I am too tired to explain it to you. Too bad, last summer I did some nice work."

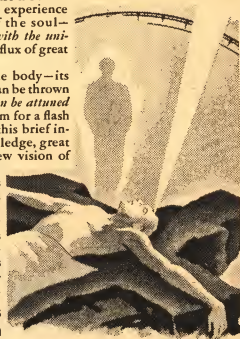
On February 10, 1878, he died. ■

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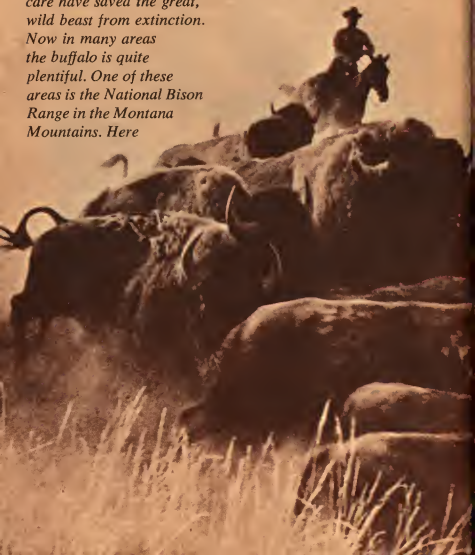
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BUFFALO

THE AMERICAN BISON was once an endangered species, but decades of careful protection and systematic medical care have saved the great, wild beast from extinction. Now in many areas the buffalo is quite plentiful. One of these areas is the National Bison Range in the Montana Mountains. Here



ROUNDUP

for ecology's sake



every fall the bison herd is driven in from the wilds by the U.S. Fish and Wildlife Service which is dedicated to the task of protecting these huge, shaggy animals from extinction. They also keep close tabs on the animals' health and maintain the herd at manageable numbers. The current ideal size of the herd is considered to be about 800. The cowboys drive the herd into corrals where the individual animals can be examined and given injections against various diseases. The new calves are branded with their year of birth for future reference. Some of the bison are sold to ranchers who want to build their own herds, and others of the animals are slaughtered for their meat. The remaining healthy 800 are turned loose once again into the wilds for another year of grazing. ■



Driven by cowboys into a corral (above) at the National Bison Range, these unpredictable animals are prodded with long poles and headed into stalls for medical examinations and injections for various diseases.

Bison commonly weigh as much as a ton. Below, this shaggy bull dwarfs the cowboy who knows that the animal can be deadly if given the opportunity to charge. He keeps a gate between himself and the bison.





There are about 15,000 buffalo left in the U.S. out of former herds numbering in the millions. These below are being herded single file through a chute so they can be accurately counted.

Most of the bison herd is returned to the wild, but certain of the animals are sold to ranchers who are building their own bison herds. Below several of the sold animals are loaded onto a truck.

BIPS Photos



Visiting Sierra Nevada

Sierra Nevada. Verna R. Johnston. Houghton Mifflin Co. (\$7.95). This is the second volume of the publisher's series, *The Naturalist's America*. If the first two are any indication, it will be a set of books that everyone with the least interest in our country's flora, fauna and eco-systems will have to possess and cherish. First of the series was Maurice Brooks' *The Apalachians*. Now we have the scholarly, but warm and fascinating observations of an astute biologist, ornithologist and ecologist, whose depth of knowledge about the great Western Sierra and its living things is matched by a remarkable lucidity, and talent with a camera.

The author teaches biology at San Joaquin Delta College. She has explored—obviously at a gait no faster than a walk—much of the 400-mile-long mountain range that she pokes and probes with keenly discerning eye, ear, and analytical mind.

Readers of this book, whether or not they have ever seen the high Sierras, will know more about the flowers, trees, shrubs; the scurrying, flitting, browsing and prowling residents of the spectacular area, than most people who have lived there a lifetime.

Vivid, memorable descriptions of the often curious habits of forest, plain and desert wildlife abound. You'll watch appealing little flying squirrels soar from tree to tree and perform their "tightrope" acrobatics, dangling by "one hand" from vines and clotheslines. There are documented tales of pack rats, stealing utensils and watches from campers, to feather their nests (in one case, a

pack rat swiped a sleeping camper's gold pieces, left a lump of horse dung in their place, and nearly broke up life-long friendship). You'll watch the courtship rituals of odd little creatures like the Sierra Nevada salamanders that dance and stroke each other with great affection; observe the process by which the little "skink" lizard attacks and overcomes one of its favored delicacies—scorpions.

There's a great description of the "noisy, gregarious" acorn woodpecker of the mid-mountain forests, who drills holes in tree bark and tamps acorns into them "for a tight, flush fit" against the long, hungry winter months. One such "cupboard tree" had 31,800 storage holes in its bark. Even more fascinating was the woodpecker who drilled a hole in the cedar shakes of a cabin wall, which would not "fill up" because the acorns kept going through and dropping inside. A pile of 62,100 acorns was later found on the cabin floor—all of which may say something about woodpecker "intellect."

But beyond all these delightful insights to Sierra wildlife are the recorded facts about the changing ecology of the land, which the author traces from Tertiary times, through the advent of man and his farming, goldrushes and other depredations. The killing off of grizzly bear and mountain lions, for instance, to avoid decimation of cattle and sheep herds, resulted in a population explosion of mule deer, which overbrowsed the low growth (including many grasses, flowers and the chapparal) resulting in the disappearance of many small creatures.

From the western foothills, the author takes us tromping, almost mile by mile, over the entire range—up the talus slopes, along the towering granite cliffs, through the forests of giant redwoods, pines and native black oaks to the jagged alpine ridges—over the top and down the precipitous eastern slope to the desert floor. All the way, she draws your attention to the calls of birds and animals, flashes back to their earlier days, spangling her narrative with documented and pertinent anecdotes about them, with a unique touch of quiet, unobtrusive humor, warmth and good nature.

Her love of the country and its life comes through on every page, yet the vital need for culling over-producing species is pointedly recognized and dealt with.

Neither does Verna Johnston mince words when it comes to dealing with the effect of insecticides on the struggling ecology; the crime of Lake Tahoe's polluters or the ruthless and persistent drive of commercial interests and thoughtless residents in a pristine wilderness that will not always be able to maintain its delicate balance without the help, rather than the hindrance, of mankind.—RFD

A Modern Look at Monsters. Daniel Cohen. Dodd, Mead & Co. (\$5.95) Monsters have "appealed" to men for years and have found scores of believers for as long as they have been around. The number of true believers today does not compare with that of medieval days, to be sure, but you would probably be surprised at how many "educated" people still believe that some monsters (e.g. the Loch Ness monster) still exist.

Mr. Cohen has taken a popular subject and presented many facts and theories about the origins of many of our most popular monsters. It's a book that most people will find fascinating, but if you're one of those true believers—or monster buffs, as he calls them—you're liable to disagree quite radically with Mr. Cohen's theories and facts. He is an avowed skeptic, as he made clear in an earlier book (*Myths of the Space Age*) and has not written this book to reinforce anyone's ideas that some monsters do exist. But if you want to get some interesting data on monsters—their beginnings (cave man art depicts

no monsters at all, so it is "only with civilization that monsters seem to play a significant role"), how they affected people at different periods in history and the "evidence" for their existence, then you'll surely enjoy a *Modern Look at Monsters*.

You'll read all about the greatest monster of them all—the dragon, about the Great Sea Monster, the Abominable Snowman and the celluloid-immortalized creatures from outer space. No one could ask for more, except perhaps a chapter on "horror" monsters such as Dracula and the Wolfman. But one can't have everything.—JGF

A Pictorial History of Oceanographic Submersibles. James B. Sweeney. Crown. (\$9.95). There has been a rash of books, pamphlets, brochures, articles and what-have-you on the wide and growing variety of deep-sea vehicles designed to probe "inner space" to the depths of its deepest deeps. But few have covered the subject as thoroughly or with such in-

(Continued on page 100.)

Answers to the sound quiz

Questions appear on p. 74

1—c Ice. The velocity of sound in ice is about 10,500 feet per second. This value is almost twice as great as the velocity in water. The high rigidity of ice accounts for its high velocity. The intermolecular forces are stronger in a solid and bring a quicker rebound after compression.

In 1—a the velocity of sound in air is about 1,090 feet per second at 0° C. The velocity increases with temperature. At 68° F. the velocity is about 1,130 feet per second.

In 1—b the velocity of sound in water is less than 5,000 feet per second. Water has some rigidity, especially when compared with air, which has almost none. Density also has some effect on velocity.

2—b The train approaching the man. The wave fronts are squeezed together, more wave lengths reach the man per second. This results in a decrease in wave length and an increase in frequency or pitch. The velocity of the sound wave is constant and equal to the product of the wave length and frequency. When wave length decreases, pitch or frequency increases.

In 2—c when the train recedes from the man, the wave fronts are pulled apart, making the wave length longer with a decrease in frequency.

In 2—a the train is stationary; therefore the pitch or frequency of vibration remains constant.

3—a Destructive interference. A and B, two identical waves opposite in phase traveling in the same direction

cancel each other, and no displacement occurs and therefore, no sound. If you have a tuning fork, both prongs produce the identical fundamental note. When you rotate the plane of the fork to a 45-degree angle near one ear, the waves in the direction of your ear are opposite in phase. The sound almost dies out. You may still hear the sound in your other ear, however.

In 3—b a single wave and its reflection sets up a standing wave. Standing waves have nodes (points of no displacement) and loops (points of maximum displacement). These are found in vibrating air columns and strings of musical instruments.

In 3—c constructive interference

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occurs when waves A and B add up to produce a wave of greater amplitude (shown as a dotted line).

4—c Flute. It encompasses about three octaves. The band of frequencies extends from about 261 per second (middle C) to 2,093 per second. Overtones produced along with the fundamental note may be as high as 14,080.

In 4—a the piano spans nearly seven and a half octaves from about 27.5 vibrations per second to about 4,224 per second.

In 4—b the cello covers a span of about three and a half octaves in a lower frequency range than the flute.

The cello's range is from about 61.7 per second to about 1,046.

5—b This shows the string vibrating in two segments, which is the next possible mode of vibration after the string vibrates as a whole in 5—a. In 5—a a whole wave length is twice the length of the string, which is twice as long as a whole wave length in 5—b. Hence the frequency of 5—b would be twice that of 5—a. If 5—a were a frequency of 256, then 5—b would have to be double that, or 512 (an octave higher) so that the frequency times wave length in each case would be the same. In 5—c the frequency of the second overtone is 768.

Score yourself: 4—5 right Your score has *quality*.

2—3 right You're on the right wave length half the time.

0—1 right Your low pitch is out of range.



"So glad you enjoyed it, Commander. . . . It's an old family recipe of the butler's."

Short cuts to the answers



SHORT CUTS IN ARITHMETIC are valuable time savers. If a given answer to some problem can be found in 30 seconds instead of 30 minutes, the quicker method is certainly the better one.

A good case involves a fascinating story about one of the world's most famous mathematicians, Karl Gauss. According to this story, when little Karl was a fourth-grade schoolboy in Germany, the teacher one day told the class in arithmetic to add up all the numbers from 1 to 100, and see if they could do this in ten minutes.

Instantly, a score of pencils were whipped out and began to scribble down long columns of figures—1,2,3,4,5,6,7 etc. Obviously, it would have taken each pupil a couple of minutes just to complete the tabulation, before even starting to add the totals. Nevertheless, within 30 seconds the hand of one pupil was raised, waving vigorously.

"Yes?" inquired the teacher. "What is it, Karl? Don't you understand the problem?"

"Yes, sir, I understand it. And I've got the answer."

Puzzled, the teacher replied, "Why, that's impossible! You haven't even

written down all the numbers."

"I know," said little Karl. "But that's not necessary. You see," the boy continued with the patient tone of a prodigy dealing with a stupid grownup—"you see, sir, the first number (1) added to the last number (100) makes 101. Also the second number (2) added to the next-to-last number (99) makes 101. So, all the other similar pairs add up to 101. As there are 50 pairs of 101, you just multiply 101 by 5, making 505, and then add a zero. So that's your answer—5050."

What the flabbergasted teacher thought or said isn't on record. But the moral of the tale is clear—that analysis of any particular problem is the first and most important step in its solution.

Sometimes the quickest way to add up a row of odd numbers *is not to add them up at all*. For the total can be found instantly by multiplication.

For instance, adding up $1+3+5+7+9$ in the usual plodding manner will show that they sum up to 25. However, if we merely note that there are 5 consecutive odd numbers in the group just mentioned, we simply multiply 5 by itself (squaring 5, as mathematicians would say), and the answer is found in a jiffy—25. In a longer series of (say) 10 consecutive odd numbers, we square 10 and get

the answer at once—100. For example:

$$1+3+5+7+9+11+13+15+17+19=100 \text{ (equals } 10 \times 10\text{)}$$

In short, any series of consecutive odd numbers, starting always with 1 and ending wherever you please, has a summed value equal to the square of the number of those numerals. If there are 20 of them in a row, their summed value is $20 \times 20 = 400$; and so on indefinitely.

This brings us to an interesting variant of this same principle.

By grouping consecutive odd numbers in a different way, we can discover the value of each group by multiplication of a different kind—namely, by cubing a number instead of squaring it. That is, instead of multiplying a number by itself *once* (which is squaring it) we multiply a number by itself *twice* (which is cubing it). Just as 2 squared is $2 \times 2 = 4$, so 2 cubed is $2 \times 2 \times 2 = 8$.

With this simple principle understood, it's now easy to grasp the following mathematical curiosity which, as before, is based on an unbroken series of consecutive odd numbers, these being arranged in groups of steadily increasing size.

As this may sound a bit complicated in description, an actual step-by-step process shown below will make matters plain as daylight:

1	$= 1 \times 1 \times 1 =$	1
3+5	$= 2 \times 2 \times 2 =$	8
7+9+11	$= 3 \times 3 \times 3 =$	27
13+15+17+19	$= 4 \times 4 \times 4 =$	64
21+23+25+27+29	$= 5 \times 5 \times 5 =$	125
31+33+35+37+39+41	$= 6 \times 6 \times 6 =$	216

And so on and so on and so on.

It will be seen, when examining the foregoing table, that the consecutive series of odd numbers are carried

right through all the groups. Each group has one more number in it than its predecessor; the summed value of each group is shown in the right-hand column; and that very value is the cube of the number of separate numerals in the group. The second group, for example, has 2 numerals in it, and their summed value is 2 cubed; the third group has 3 numerals in it, and their summed value is 3 cubed, etc. It is this last fact, of course, which is particularly fascinating.

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Solving the mystery of The Street of the Dead

by L. Sprague de Camp

IN A.D. 1521, Hernando Cortes and his army vanquished the Aztec city of Tenochtitlán and built a new town, Mexico City, on its ruins. The march to Tenochtitlán had taken the Spanish conquerors through the ancient remains of Teotihuacán (pronounced teh-o-tee-wa-KAAN), a city which contained two huge pyramids, for many years in abandoned ruins and covered with trees and scrub.

After the Conquest, Spanish and Hispanified Indian chroniclers went back to the pyramids and questioned the defeated Mexicans who lived nearby about the history of Teotihuacán. The Mexicans had plenty to tell.

To begin with, the name of the city

meant "abode of the gods." Some said that Teotihuacán had been built by gods; others, by giants.

Before the rise of the Aztec Empire, said still others, a race of mighty builders called Toltecs had ruled central Mexico. Teotihuacán had been one of their capitals—perhaps the legendary Tollan. Another tale told how the gods Nanahuatzin and Tecuciztecatl had thrown themselves into the sacred fire and emerged as the sun and the moon respectively. The pyramids marked the sites of these gods' self-sacrifice and were, therefore, called the Pyramid of the Sun and the Pyramid of the Moon.

A mile-long avenue, lined by smaller ruins, connected the two pyramids. Believing that these smaller

structures were the tombs of priests and chiefs, the Aztecs called this avenue the *Micoatl* or Street of the Dead. The site still had religious significance. The late Moctezuma, slain by his own people during a battle, had once performed religious rites there.

In the centuries after the Conquest, however, it became plain that the Aztecs had not really known anything definite about Teotihuacán. In fact, the city had already lain in ruins for half a millennium when the Aztec Empire first arose and the Aztecs began keeping records. These records were pictures on sheets of deerskin or agave paper, like comic strips without written words.

In the 19th century, pioneers in the youthful science of archaeology began

Temple of Quetzalcoatl (also called the Temple of the Frog) means "feathered serpent," and this picture shows why the ancient temple received its name. The feathered serpents here alternate with heads of Tlaloc, the rain god.

to investigate Teotihuacán. Prominent among these was Zelia Maria Magdalena Nuttall Pinart (1857-1933). She achieved much by finding and deciphering Aztec picture-manuscripts and by collecting and describing little clay figurines from various parts of Mexico, notably from Teotihuacán. Whereas the figurines from older sites are merely crude, generalized images of human beings, those from Teotihuacán take on the definite forms of the gods of the ancient Mexican pantheon.

Following her, a pioneer Mexican archaeologist, Leopoldo Batres, became "Guardian of the Monuments" and turned his attention on the Pyramid of the Sun at Teotihuacán. Around 1905, thinking that this pyra-



An ocean full of medicine

People have sought ocean "cures" for centuries, but now scientists are discovering just what valuable medicines exist in the depths.

by William and Ellen Hartley

WHEN THE GREAT American boating public launches into another season next April, it will be enjoying itself immersed in the greatest potential drug store known to man. We've known about it all the way back to pre-history; but until recently no one has stepped up to the counter. The source of probable medical supplies is, of course, the oceans of our world.

The halogen, iodine, was identified in 1811 by Bernard Courtois. In its most primitive form, it comes from the ash of certain types of seaweed. But as early as the era of the Phoenicians (and probably much earlier) man looked to the sea for medical aid. He didn't know exactly why ocean products helped his ailments; but he recognized that they had a beneficial effect.

As recently as 1930, some individ-

Photos: Wometco Miami Seaquarium

Puffer fish skin, intestines contain tetrodotoxin, valuable medicinally, but lethal if the fish is not prepared properly for eating.

You feel colder because of the WIND CHILL FACTOR

by Bob Kevern

THE TEMPERATURE outdoors is 47° F. You put on what you think is the proper weight clothing and step out into the cool air. Soon you begin to realize however, that it's chillier than you thought. In fact, it feels downright cold and you know that if you are going to spend any length of time outside you're going to need warmer clothing.

This sort of thing has happened to every outdoorsman and camper and it's all because of the wind. Even though the temperature may be 47°, add a 15-mph wind to that and the combined effect on the exposed flesh of the human body is the same as standing in no wind at a temperature of 32° F.

This combining of the air temperature (in this case 47°) and the wind speed (15 mph) equals out to what we call the "chill temperature." The United States Army was first to do research in this field. They found that though soldiers thought they were properly dressed for a given air temperature, many times they complained of being too cold. Scientists knew the wind produced the feeling of being colder, but it wasn't until they began experimenting that they found out just how much the simulated effect of temperature and wind had on the human body.

The chill comes from the wind which cools away our body heat. As wind rushes around a body, outer

Photos: Photo Trends

On the Barrier ice of Antarctica, left, ambient temperature was -47° F. when this photo was taken. But winds gusting to 40 mph produced a chill factor sending it to an effective -128°. To withstand such cold these men wear heavily insulated suits.



What noise does to plants

CAN NOISE DAMAGE or even kill plants? A Denver, Colorado, college student theorizes that loud noise—specifically rock music—may have a destructive effect not only on plants but also on human behavior.

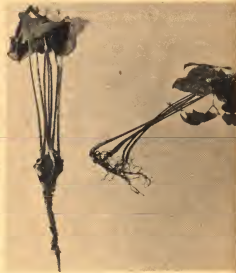
For two years Mrs. Dorothy Retallack, a 48-year-old recent graduate of Temple Buell College, has experimented with potted plants. She found that the plants she exposed to loud

rock music withered and finally died. Those plants she exposed to soft, semi-classical music reacted favorably and even grew toward the sound.

Mrs. Retallack's experiments were supervised by her biology professor, Francis F. Broman, who saw to it that scientific methods were used. A mother of eight children, Mrs. Retallack began her experiments as a required project in a college biology



course she took when she was working on her bachelor degree along with several of her children. The middle-aged housewife-student, a music major, sent the biology department at Temple Buell into a mild tizzy when her observations were made public. She thinks there may be a link between loud rock and anti-social behavior among college students, and she plans to continue her experiments. ■



BIPS Photos
Mrs. Dorothy Retallack stands in front of the environmental chamber where her potted plants are flourishing on a diet of light, water, nutrients and Bach organ music. Other plants died when exposed to rock.

The withered stems and leaves of a bean plant at right in the top picture were produced when the plant was exposed to rock music. The healthy plant in same picture was exposed to light classical music.

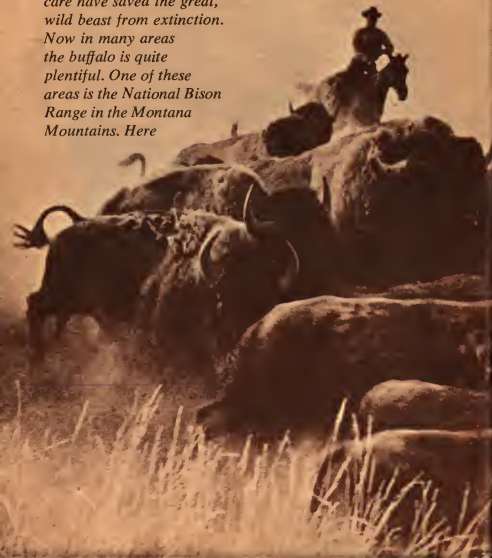
The scrawny root system of the bean plant at right in the picture above belongs to a plant exposed to loud rock music. The healthy roots at left belong to a plant raised with quiet, bland music.

BUFFALO

THE AMERICAN BISON was once an endangered species, but decades of careful protection and systematic medical care have saved the great, wild beast from extinction. Now in many areas the buffalo is quite plentiful. One of these areas is the National Bison Range in the Montana Mountains. Here

ROUNDUP

for ecology's sake



every fall the bison herd is driven from the wilds by the U.S. Fish and Wildlife Service which is dedicated to the task of protecting these huge, shaggy animals from extinction. They also keep close tabs on the animals' health and maintain the herd at manageable numbers. The current ideal size of the herd is considered to be about 800. The cowboys drive the herd into corrals where the individual animals can be examined and given injections against various diseases. The new calves are branded with their year of birth for future reference. Some of the bison are sold to ranchers who want to build their own herds, and others of the animals are slaughtered for their meat. The remaining healthy 800 are turned loose once again into the wilds for another year of grazing. ■



Driven by cowboys into a corral (above) at the National Bison Range, these unpredictable animals are prodded with long poles and headed into stalls for medical examinations and injections for various diseases.

Bison commonly weigh as much as a ton. Below, this shaggy bull dwarfs the cowboy who knows that the animal can be deadly if given the opportunity to charge. He keeps a gate between himself and the bison.



There are about 15,000 buffalo left in the U.S. out of former herds numbering in the millions. These below are being herded single file through a chute so they can be accurately counted.



Most of the bison herd is returned to the wild, but certain of the animals are sold to ranchers who are building their own bison herds. Below several of the sold animals are loaded onto a truck.



RIPS Photos